

Directorate General for International Co-operation, the Netherlands
Department of Agricultural Engineering, University of Nairobi

END - OF - PROJECT REVIEW
UNIVERSITY OF NAIROBI/DEPARTMENT OF AGRICULTURAL
ENGINEERING (KE/92/030)

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COMMENTS ON THE DRAFT REPORT

The final draft report was presented to the donor in early January 1996. By the end of February 1996, a letter by the Chairman of the Department, comments by the Academic Staff, and a reaction by the donor had been provided to the Team.

These comments on the draft report received from the Department of Agricultural Engineering and the reaction of the Royal Netherlands Embassy to those comments have been studied carefully.

A paramount conclusion of the Team was that the Department missed the main developments in thinking about agricultural production in East and Southern Africa. The overall understanding of the Team is that the comments and statements of the Department demonstrate the 'engineer' point of view and underline such a conclusion of the Team.

Interestingly, the Department apparently accepts the subsequent recommendation of the Team that the curriculum needs considerable change (brainstorming by the Department about this indeed has started recently) and even requests the donor for 20 years, to financially assist the Department with this. The department further states that a Farming Systems approach is not (yet ?) official policy at the level of the ministry, and that the T&V system as promoted by the World Bank is officially still in force. This is correct to a certain degree, but negates the fact that important changes are being made and have been achieved over the past years - also in relation to the extension system. An important example in this (KARI's approach in the implementation of NARP II), is given by the Department in its reaction.

The Department rightly observes that the Draft Animal Power Project got considerable attention in the report. The donor deliberately included an expert in this field in the Team and, as a consequence, ample attention is to be expected. The Team considers such attention as justified. First, the DAP project has always featured as one of the success stories of the Department. Second, the Team was to have an advisory role on making the programme offered by the Department more sustainable. The Department has frequently indicated that especially activities originating from the DAP might in the future generate income for the Department. This warrants an in-depth assessment of the DAP by the Team.

Considering the above, the Team sees little reason to make changes in the report but honours the request made by the Department and includes in the final report (as Annex V) the comments given by the Department's Academic Staff.

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ABBREVIATIONS AND ACRONYMS

ADP	Animal Draft Power
AGROTEC	Agricultural Operations Technology for Small Holders in Eastern and Southern Africa
ASAL	Arid and Semi-Arid Lands
ATNESA	Animal Traction Network for Eastern and Southern Africa
BSc	Bachelor of Science
DAREP	Dryland Agricultural Research and Extension Project
DDCU	District Demonstration and Contracting Unit
FAO	Food and Agriculture Organisation (of the UN)
FS	Farming Systems
FSA	Farming Systems Approach
FSR	Farming Systems Research
GoK	Government of Kenya
GoN	Government of the Netherlands
IAC	International Agricultural Centre (Wageningen, Netherlands)
IRDC	International Rural Development Centre (of SUAS)
ISNAR	International Service for National Agricultural Research
JICA	Japan International Co-operation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kenya Agricultural Research Institute
KENDAT	Kenya Network for Draft Animal Technology
KSAE	Kenyan Society of Agricultural Engineers
KSPCA	Kenya Society for the Protection and Care of Animals
LEISA	Low External Input Sustainable Agriculture
MoA	Ministry of Agriculture
MOALD&M	Ministry of Agriculture, Livestock Development and Marketing (Kenya)
MSc	Master of Science
NALRP	National Agriculture and Livestock Research Programme (Tanzania)
NAMA	Network for Agricultural Mechanisation in Africa
NARO	National Agricultural Research Organisation (Uganda)
NARP	National Agricultural Research Programme (Kenya)
NGO	Non governmental organisation
OPS	Office for Project Services
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
RNE	Royal Netherlands Embassy
RRA	Rapid Rural Appraisal
RSCU	Regional Soil Conservation Unit (SIDA)
SAESA	Society of Agricultural Engineers in Southern and Eastern Africa
SAP	Structural Adjustment Programme
SCIP	Smallholder / Second Coffee Improvement Project
SIDA	Swedish International Development Authority
Sida	Swedish International Development Co-operation Agency (merger of a.o. SIDA and SAREC)
SIDP	Smallholder Irrigation Development Project
SUAS	Swedish University for Agricultural Sciences (in Uppsala)
T&V	Training and Visit (extension system)
TA	Technical Assistance
ToR	Terms of Reference
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UON	University of Nairobi

USA/US
WB
WEKASP

United States of America
World Bank
Western Kenya Agricultural Support Programme

ACKNOWLEDGEMENTS

The review team would like to thank, firstly, the Royal Netherlands Embassy in Nairobi, which entrusted the team with the responsibility to execute this end of project review. The RNE has been completely open to discuss the successes and constraints encountered during the execution of the project when the team presented its de-briefing.

Similar frankness and forthrightness were met during all meetings and discussions that the review team had during the process of evaluation. Whether the persons involved in the discussions belonged to the Department at the University of Nairobi, to another University, to a Ministry, or to another donor organisation, they tried on the whole to provide the team with all the relevant information they possessed.

According to the review team, this implies that all those involved with the project are highly committed to it and put the importance of its success in the forefront. For this sincerity the team would like to thank all those who contributed their time and experience to the evaluation process.

Without the wholehearted collaboration of the staff of the Department, this review would hardly have been possible.

In the following, the report arrives at several conclusions and recommendations. These were developed during the evaluation process by the review team and have been tested and checked during subsequent discussions. This testing was done with staff involved in the project and with staff working in similar or closely related activities. Since many informants presented the team with personal opinions, it was decided that no specific names or functions of those who are in support of (part of) the contents of this report should be mentioned. This also implies that in the text no reference should be made to such support.

The review team wishes to state that, although in certain aspects disagreement was met, the conclusions and recommendations arrived at by the team were supported in general by the far majority of the informants and resource persons.

All conclusions and observations and possible mistakes are, nevertheless, the sole responsibility of the review team.

PREAMBLE

Duration and timing

The team would like to observe that 10 days was a short time to review a programme that was of 20 years duration and involved over 100 person-years of research and teaching. Although December is a difficult period to get hold of people in Kenya, the team managed to get an adequate amount and variety of information. The team holds the opinion that information collected is correct and that the conclusions and recommendations were derived from proper facts.

Methodology

The methodology for this review was left to the team (see ToR in Annex I).

On the first day the team sat together and decided that the first two days would be used for interviews with staff at the Department of Agricultural Engineering. These two days all three team members attended the same interviews. This set-up provided all team members with the same basic information. On the third day, the occasion of the Annual International Conference of Agricultural Engineers at the Jomo Kenyatta University for Agriculture & Technology was profited from and JKUAT was paid a visit. The team split up to maximise the number of participants that could be interviewed. The next Saturday, the separate interviews were compared and analysed after which the outline for the report was established and certain tasks were divided. To evaluate better the impact of an activity (animal draft power) for which the Department had obtained an international reputation by the mid-1980s, Mr. Starkey went to visit contacts on this topic in Western Kenya during days 5, 6 and 7.

The two other team members after having written the first parts of the report on day 5, concentrated during days 6 and 7 on interviews with groups and organisations that can be qualified as users of the qualifications of the agricultural engineers. Interviews were held, e.g. with a major supplier of farm machinery Gailey & Roberts, with the Kiambu office of the NGO Plan International, with the Second Coffee Improvement Project (SCIP), and with the Ministry of Agriculture and Livestock Development, traditionally the employer of agricultural engineers.

The morning of day 8 was used by the team - by than together again - to brief one another and identify progress. At the same day, at the office of Sida at the Swedish Embassy, the SAREC contribution was discussed (besides the Netherlands support, the Department was and is supported by Swedish SAREC).

The morning of day 9 was used to prepare for the de-briefing to be given later that day. Contrary to previous missions, but in consultation with the Department and the Royal Netherlands Embassy, it was decided to do the de-briefing not only to the RNE but also and at the same occasion, to the staff of the Department.

The 10th day was used by the team to discuss the reactions to the de-briefing and for two members to prepare the materials that would be used for the writing of the final draft report. For these two the mission ended at that day. For the third member, the team leader, an additional five days were used to compile all information and materials into the final draft report.

To maximise on the specific knowledge of each of the team members, Mr. Bos concentrated on the wider context of the project, besides being the leader of the team. Mr. Mutiso focused on the institutional aspects, and Mr. Starkey on animal draft power and research aspects.

0 EXECUTIVE SUMMARY

By the middle of the 1970s, the Netherlands Government provided an extensive input in the irrigation sector in Kenya, including a considerable input in expatriate personnel. To see to sufficient and qualified counterparts, a project for support to the Department of Agricultural Engineering was committed. This project ended by 1 January 1996, after 20 years of continued support by the Netherlands Government.

The short-term objective seems to be achieved. A well-trained staff of about 15 lecturers exists, mostly PhDs. Close to 400 students enrolled at the Department and 375 graduated, and adequate facilities like class-rooms, offices and laboratories are in place. Equipment provided under the project, in principle, is sufficient. Strategic thinking at the Department has hardly concentrated at solving the problem of future sustainability while the GoK input in the University system is inadequate for survival and will continue to decrease. The last phase (out) of the project was intended by the donor to prepare the Department for 1996 and thereafter, but basically the only serious solution considered is to secure another donor (or 'horse') to survive.

At the time the project started, the global thinking was that the need for improved agricultural production would be satisfied through the development of better inputs like new varieties, fertilisers, etc. All these improved inputs would be generated at research stations and at Universities and disseminated through national extension systems. In line with this 'green revolution' thinking was the assumption that smallholder production was primitive and old-fashioned, and that it would soon give way to efficient, modern, specialised large-scale production using tractors and combine harvesters.

This thinking deeply affected the way national agricultural research was organised with a commodity and factor orientation, and the way extension systems were supposed to function as a deliverer of a ready-to-use package. Where technologies are concerned, the focus was on mechanised farm power, large scale storage, etc.

By the middle of the 1980s it became more and more accepted at formal national and international levels that in sub-Saharan Africa this approach had failed and that a different approach had to be organised. Agricultural research in the region is now gradually switching to a farming systems approach, and extension is looking for more unified and participatory methods and systems. A general observation made by those involved in such transition processes is, that especially the way research and extension staff have been trained and educated, represents a serious constraint. It generally has been accepted by now that smallholder production is and will be the mainstay in the region.

Agricultural engineering, traditionally seen as an engineering topic, has not yet made any significant changes in its thinking. The Department of Agricultural Engineering at the UON still operates along the same premises that were in force 20 years ago and has not been affected by the mainstream of conceptual development in agricultural production in the region. Thus, where - at a first glance - the short-term objectives of institution and capacity building have been achieved by the project, the long-term objective to improve agricultural production of smallholders, has not been met. Training and research at the Department have very little to do with the existing smallholder production system in the region.

The staff at the Department is predominantly trained at Universities in mid-western USA, at universities that were purposely established to support that large-scale, mechanised production system. Little wonder that most feel disoriented when coming back as PhDs after six or more years when they are faced with the reality of Kenya's smallholders.

A specific example that supports the above conclusions is provided by the Animal Draft Power project, for which the Department had international fame in the 1980s. Typically, this ADP developed a technology at the University and tried to disseminate the "perfected" product to the farmers. Now, 10 years later, the adoption rate is negligible.

A research strategy is missing, despite strong recommendations in earlier review reports.

The analysis of the subjects the students used for their MSc theses illustrates the focus on the large scale, commercial sector and the unawareness of the smallholder production that generates over 80 % of the agricultural produce in Kenya.

Yet, some indications exist (a few attempts were made to arrive at strategic plans, etc.) that with the proper management, it might be possible to re-orient (part of) the Department towards the smallholder production sector and amalgamate the now highly divided Department. Such a change - probably to be managed from the outside - should include training of the staff in socio-economic aspects of smallholder production, in participatory techniques, and in involvement with FS teams. Changes in the existing curriculum should achieve the same for future students and prepare them better for the market. Now the far majority of the graduates is facing unemployment.

To make the Department more able to become self-sustainable, staff should be trained in entrepreneurial / consultancy skills. The fact that quite a number of the staff already spends a considerable amount of their time on private consultancies could be profited from.

For this managed change, external support (donor) is required. The chances of success are unclear but can be looked into in more detail.

The Netherlands Government decided that Phase IV would represent a phasing out and that 20 years of support should be sufficient. Yet, a number of reasons can be given to reconsider such a decision, the most important one being that the Netherlands Government is largely involved in the changes in agricultural research that are taking place and is preparing a substantial programme in Western Kenya of which unified extension is a central element. It could make sense not to neglect the third side of the triangle and continue to pay attention to the education part. Agricultural engineering has a role to play in the new participatory approaches since technology development lagged behind.

As stated above, the changes for success are difficult to assess by this team, but a possible collaboration with Sida / SAREC that supports the Soil & Water section of the Department might be possible. The team was informed that Sida is serious in re-orienting this section while it cannot pay attention to the two other sections of Farm Power and Machinery and Processing and Structures.

It was also observed by the review team that technology development for smallholders has an important gender aspect. Quite a number of smallholder technologies determine and dominate especially the life of the female farmers, and improvements will particularly better their situation. Since smallholder technology development is so intimately linked to women, it is noteworthy that only very few female students have enrolled and that the staff composition of the Department is fully male.

The proposed re-orientation and especially a modified curriculum could make the Department more accessible to female students.

1 PROJECT CONTEXT

1.1 The dilemma

The classic dilemma that was part of almost all the discussions the team had, was observed early in the project's implementation. It was nicely, and in a positive way, described in the 1982 review on page 13 (last paragraph) as a "creative tension". Yet, the warning in the last sentence that "the philosophy which the Department adopts will be vital in determining.... the commitment and ability to serve the rural smallholder ..." never played a role in project related decision making afterwards. This, despite the importance it carries in relation to the achievement of the long-term objective of the project.

Where one of the lecturers of the Department stated "... as academics, we are working in an ivory tower, and we are proud of it", others favoured the opinion that scientists / intellectuals primarily should focus on solving the development constraints of Kenya. This classic dilemma at institutes of higher learning is not unique for Kenya but a standpoint in this is essential for the evaluation of the project; without it, one cannot properly assess the impact and achievements of the 20 years the project was in operation. Is research and teaching at a University Department determined by academic and private standards and interests (the ivory tower), or is it determined by the needs of society, in this case the needs of the agricultural production sector in Kenya.

Following a review of the short-term achievements (in chapter 2), in chapter 3 the team will indicate the arguments it used to arrive at their point of view, which assumes to also be the donor's one. After which, in chapter 4, the achievements are reviewed considering the long-term goals.

In the same chapter 3, the team will describe the developments and the fundamental changes that took place in the thinking about agricultural production in East Africa; the transfer was made from high-tech, high input, and top-down 'Green Revolution' thinking to a participatory, farmer oriented approach. Especially for a project that ran for two decades an insight in this transfer is indispensable for proper assessment of impact and achievements.

1.2 Smallholder production

Essential also is the realisation that in Kenya (like in the rest of sub-Saharan Africa), the majority of agricultural production is generated by smallholder farmers. These produce both cash and subsistence crops, but subsistence cropping is still the pivot for food security, and even more so now when more and more of the food crops are grown in the semi-arid areas of Kenya.

Relevance of an activity for the agricultural production in Kenya is, to a large extent, determined by its relevance for smallholder (subsistence) production. For example, with smallholder production the aspect of power in the farming system is rather a matter of animal traction than of mechanisation / tractorisation.

1.3 Donor's policy

The donor should be commended that it left the ownership of the project with the Kenyan staff. Especially at the time when the project started, this was a novel attitude. The expatriates assigned to the project always operated as colleagues rather than as team leaders. That the ownership was very much with the Kenyan staff also transpires from the fact that only one of the staff went to the Netherlands (Wageningen) for his training,

although at that University in Wageningen, teaching and guidance can be done in English. A lecturer at the JICA supported JKUAT, on the contrary, had to live in Japan for six years to do his PhD, and spent the first year in learning Japanese. If this 'little-involvement' policy of the donor is ideologically to be applauded, it also had its negative consequences as will be made clear by this review.

Nevertheless, the overall loyalty demonstrated by the staff that were involved in the execution of the project, might be explained by the donor policy vis-à-vis the matter of ownership. However, it can be argued that the initial 10-15 years were for putting staff in place. Thus, another 10 year period could be justified to allow the staff to build up the institution.

Another important aspect of the donor's policy was the preparedness to accept a long-term commitment of 20 years. This is essential to arrive at successful institution building.

2 DIRECT PROJECT ACHIEVEMENTS

The total costs of the project mount up to the following (in NGL, according to the Department):

Phase I (1976-1981), commitment made	3,100,000
Phase II (1981-1987), commitment made	3,450,000
Phase III (1987- 1992), commitment made	4,770,000
Phase IV (1992- 1996), commitment made	1,600,000

Total	12,920,000

2.1 Curriculum development

The curriculum has been developed using the recommendations from previous review missions. The total result of changes can be studied in the Addendum to this report that contains a copy of all the curricula developed. This Addendum is of particular interest to the Donor and is, therefore, not part of the overall report but exclusively distributed to the Client (curricula on BSc, on BSc 845, on proposed changes, and on MSc).

In the 1987 curriculum for the three-year BSc degree, whose intake was A level students, only 14% of the courses could be interpreted as non-engineering. These are 1. Introduction to agriculture, 2. Economics, 3. Crop Production, 4. Animal Production, and 5. Farm Management and Extension. In this curriculum, practicals are conducted for the three years the students were on campus for three months every year. It was thus possible for a student to get nine months of practical work.

The 1991 BSc curriculum was developed to cater for the students who did not do A levels. These are the so-called 8.4.4/5 students. It was assumed that they did not get the extra two years preparation in the sciences to give them university level entry training. Consequently courses seem to have just been added: to fill the five years the students were to be at the University. For example, Thermodynamics courses increased from two for the BSc to four. That was not all. There is one course that clearly was a bow to the political powers that were then seeking loyalty from the University through the then Vice Chancellor. Similar courses were approved by him throughout the University. This course is titled Fundamentals of Development and its application to Kenya. Its utility is doubtful.

In the 1991 curriculum, practicals were reduced to only six months and spread into the second, third and fourth years. An opportunity for structuring real practicals in many sectors, smallholder sector included, was missed. This is more tragic given that many of the entrants to the university were coming from urban areas and thus the assumption that they understood the rural smallholder sector, which had been argued before, was increasingly untenable.

1985 Review Mission

This 1985 review saw its main task as not focusing on the BSc curriculum but on: "two main areas of future development...first was the need for a MSc programme ... second was the need for research and development" (p.2).

The programme involved offering "700 contact hours to the BSc Agriculture Engineering programme (and) 200 contact hours to the BSc Agriculture programme and 160 hours to the BSc Range Management Programme" (p. 8).

The 1985 mission recommended that the practical for the BSc engineering be expanded. It was further noted that the Post Graduate Diploma in Irrigation and Soil Conservation

was to be discontinued "since the same manpower requirements can now be met by graduates of the BSc (Agric. Eng.) programme." (p. 9). Therefore, there was need to get the MSc course started, for up to then those wanting this training were going overseas (p.10). Their research would be in Kenya and they can thus contribute to departmental research for "considering the heavy teaching load of staff members" (p.10).

"Agricultural engineering graduates will work on an MSc in Agricultural Engineering in one of the three areas, Soil and Water Engineering, Agricultural Power and Machinery or Agricultural Processing and Structures. The MSc Agricultural Engineering degree will be awarded by the Faculty of Engineering. Agriculture graduates will work for a MSc in one area only, Land and Water Management. The MSc Land and Water Management will be awarded by the Faculty of Agriculture and will replace the one year post graduate diploma." (p.12).

It was also recommended that after graduation in the BSc and MSc the Department would supervise and guide the graduates in the field to facilitate their registration by the Engineer's Registration Board (pp. 12-13), until there are enough engineers in the field to take over this task.

1990 Review Mission

Although the Department of Agricultural Engineering was converting from a BSc curriculum that took the A level students, to one that was taking O level students (the 8.4.5) system, this 1990 report did not comment on how the undergraduate programme was modified.

On the MSc programme, by 1990 only very few students, about 26, had graduated. The students had a choice of 36 different courses to choose from. Other than asking for more detailed description of courses and especially the manner of instruction, the mission stated that the programme compared with other curricula internationally. The issue of rural research, particularly availability of instrumentation, was highlighted. Since only a few students had gone through the programme it was not possible for the mission to make any systematic judgement about the content and to recommend changes. This review mission, from interviews of a few MSc students showed that they expected to work for government, in the private sector and self-employed as consultants (p. 11). Consequently, the mission emphasised that the programme seemed to call for generalists rather than specialists. However, it called for a systematic tracking system.

This mission also pointed out that there was no system of quality control on both the curriculum or individual courses. Quality control for the student who embarks on a thesis and drags the process was emphasised, for it reflects on selection and supervision.

This mission concurs with the conclusions of the 1990 Mission that the curriculum is comparable to other international curricula. It does not have further specific criticism about any particular courses offered, except the (for chapter 4) important observation that it is an engineering course with a slight orientation towards agriculture.

2.2 Research, theses and other publications

According to the Department's request for the fourth phase of Netherlands' support "The Department has taken a lead in Agricultural Engineering Research as evidenced by the large number of research publications, on-going staff research projects, available resources, qualified researchers and on-going post-graduate programmes." However, the Department did not furnish the review team with evidence to fully substantiate such

bold statements. Despite repeated requests, the Department was unable to produce a comprehensive list of staff publications during the period of the review.

Since the beginning of Netherlands's assistance, over 100 person-years of research (and teaching) activities have been carried out by staff of the Department. The research falls under three main categories:

- Research carried out by staff members for their own MSc and PhD Degrees.
- Subsequent research carried out by staff members within the Department.
- Supervised student projects at BSc and MSc levels.

In addition, some staff members have undertaken non-academic research in the context of consultancies, but these have not been implemented under the auspices of the Department.

Staff research for MSc and PhD has generally been undertaken away from Kenya (generally on topics of relevance to the host institution). The level appears to have been entirely satisfactory, in that most staff members have obtained their qualifications from world-class institutions. Even where the relevance of this research to the Kenyan smallholder sector has been limited or non-existent, the intellectual processes should (in theory at least) have equipped the staff to carry out relevant research projects back in Kenya. Staff appears to have produced one or two international publications relating to MSc and PhD research.

On the basis of interviews with staff and some limited lists of publications produced by Department members, it appears that few staff members were able to develop rigorous research programmes once they had completed their externally based research projects. Mitigating circumstances have been teaching loads (but staff-student ratios have been quite favourable) and low staff morale after the 1993 strike. There was no suggestion that planned research programmes have been constrained by inadequate funding or resources. Applied soil and water research has been carried on for several years, but while this has led to increasing understanding of the issues and constraints, it has not led to significant research publications. Only in recent years has there been any attempts at rigorous research relating to animal draft power.

The topics of MSc student research are listed below. Most have been in the field of soil and water engineering. Details of any national or international publications that might have arisen from these theses were not available from the Department.

The following Table 1 lists the MSc Students and thesis topics by year.

Table 1 *Topics for theses by MSc students*

1. Karanja, A.K. 1981. The Use of Infiltration Parameters in the Design of Long Furrow Irrigation in Lower Tana Basin.
2. Chuaga, F.N. 1981. Water Balance Study of Thiba Section of Mwea Irrigation Settlement.
- 3.* Butuk, N.K., 1983. Fluidized Bed Combustion and Gasification on Corn Cobs.
- 4.* Barrow, E.G.C., 1985. An Analysis of Human and Environmental Factors in the Agricultural Development of East Pokot (Nginyang Division, Baringo District, Kenya) - A Case Study Vol. I & II.
- 5.* Odeck, O.L. 1986. Evaluating Field Application Efficiency for Rice Irrigation Systems.
6. Busere, N.S. 1989. The Effect of Surface Stone Cover on Soil Loss and Runoff.
7. Bekele, M.W. 1989. The Influence of Surface Residue on Soil Loss and Runoff

8. Chepsoi, J.K.T. 1990. Hydraulic Performance of Small Basin Irrigation.
9. Kamau, B.C.L. 1990. Financial Evaluation of Private Smallholder Pumped Irrigation Projects in Kiambu District, Kenya.
10. Gachimbi, L.N. 1990. Land Degradation and its Control in the Kibwezi Area, Kenya.
11. Gicheru, P.T. 1990. The Effects of Tillage and Residue Mulching on Soil Moisture Conservation in Laikipia, Kenya.
12. Muturi, S.M. 1990. Technical Evaluation of Furrow Irrigation in Bura Irrigation Settlement.
13. Mwangi, J.N., 1990. Evaluating the Technical Performance of Kibirigwi Sprinkler Irrigation System.
14. Ndugo, K.K. 1990. The Performance of Animal Drawn Mouldboard Ploughs.
15. Nindo, C.I., 1990. Some Performance Aspects of Seed Maize Processing Operations.
16. Mburu, J.K. 1990. De-Watering and Drying Characteristics of Coffee Pulp.
17. Mwithaga, G., 1990. Change of Pyrethrin Content During Drying of Pyrethrum Flowers.
18. Kanali, C., 1990. Effect of Soil Compaction by Transportation Vehicles on the Sugarcane Fields of Mumias Sugar Company.
19. Njau, F.K., 1990. An Investigation of Safety Aspects in Selected Agricultural and Industrial Working Environments.
20. Owende, P.M., 1990. Development and Performance of a Toolframe for Mechanical Sugar Cane Stool Destruction.
21. Nyaguti, J.O. 1990. Drainage for Salinity Control in Kimorigo/Kamleza Irrigation Schemes.
22. M'Marete, C.K. 1991. The Bearing Capacity of the Soils of Ahero Irrigated Rice Field under the Exposure to Land.
23. Nyagah, C.N. 1991. Evaluation of Seepage Losses in Unlined Canals of Bura Irrigation Scheme.
24. Chiti, R.M. 1991. Effects of Farmyard Manure on Soil Surface Sealing and Crusting of Disturbed Top Soil - A Case Study of West Pokot, Kenya.
25. Gebre-Georgis, G.Z. 1991. A Comparison Between Conservation and Conventional Tillage Systems for Maize Production.
26. Moges, A. 1991. Water Conservation and Crop Production Under Two Agroforestry Systems: A Laikipia District Case Study.
27. Mukui, H.M. 1991. Evaluation of the Effect of Surface Soil Removal on the Growth of Wheat.
28. Mwaniki, J.M. 1991. A Comparison of Different Grasses as Filter Strips for Soil and Water Conservation on Crop Land.
29. Home, P.G., 1991. Drainage of Lowland Sugarcane Fields: Mumias, Kenya.
30. Nyaanga, D.M., 1991. Factors Affecting the Bulk Size of Potatoes During Storage.
31. Gikonyo, J.K. 1992. Influence of Drip Irrigation and Ground Water on Soil Water Balance of a Fluvisol in Kapsengare, Kenya.
32. Gathenya, J.M. 1992. Water Balance of Sections of Naro Moru River.
33. Mati, B.M. 1992. The Influence of Crop Cover on Soil Erosion by Splash.
34. Akal, A.B. 1992. An Investigation into the Causes and Dynamic of Slope Cutting in Timau area, North Western Foot Slopes of Mt. Kenya.
35. Fuchaka, P.W. 1993. Evaluation and Calibration of Field Techniques to Quantify Crop Cover.
36. Mwangi, T.H., 1993. Runoff Harvesting Potential for Crop Production in Kitui, Kenya.
37. Marenja, M.O., 1993. An Operational System Model for Raw Material Flow in the Sugarcane Mill Yard of Mumias Sugar Company
38. Gitonga, M. 1993. Gulley Development and Control on a Volcanic Ash Soil at Okaria, Kenya.
39. Gikonyo, J.K. 1994. Sediment Yield Studies in the Mathare River Catchment.

40. Onyando, J.O., 1994. Estimation of Runoff Volumes and Peak Rates from Rural Catchments in Kenya.
41. Shitanda, D., 1994. Physical Properties of Crusade Oil from Indigenous Oilseeds in Kenya Compared to those of Petroleum and Conventional vegetable Oils.

*NB * MSc theses studies studied and submitted in Universities abroad.*

As far as other publications are concerned, the team cannot present a proper insight in the publications the Department produced. From the first day of the mission, the Department was requested to provide the team with this information. Only on the last day of the 'field work' a list was given for the publications made by Dr. Kaumbutho and one for Dr. Mwaura. These two lists are in Annex IV.

2.3 Animal draft power programme

An Animal Draft Power Programme has been operating within the Department of Agricultural Engineering since the early 1980's. Over a period of 14 years, it has consumed considerable staff time and resources. In the third phase about one third of the Dutch co-ordinator's time was devoted to this programme. Even in recent years, with only about 20 % time allocation of the expatriate coordinator, activities and salaries related to animal draft still accounted for about 10 % of the total forth phase budget.

In the early 1980s, two members of staff (the then Chairman Mr G. Muchiri, and a visiting Lecturer from the Netherlands, Mr Dibbits) wrote about the importance of animal power in the smallholder sector of Kenya. As a result, an Animal Draft Power component was included in the Integrated Smallholder Agricultural Engineering Research Proposal of 1981 (Fowler and Kinyanjui in 1982).

During the period 1981-85, Mr Dibbits played a very active role in developing animal draft power initiatives at Kabete. Oxen and donkeys were trained and a variety of prototype carts, implements and harnessing systems were assessed. Particular attention was placed on modifying prototype collar harnessing systems. With the assistance of Mr Micuta of the Bellerive Foundation in Switzerland, modified collar harnesses were developed, and found to be suitable in on-station trials.

The persons involved in the launch of the Animal Draft Power Programme appear to have had a flair for publicity and stimulated much interest in their work. The new (prototype) harnesses were demonstrated during agricultural shows and papers and articles describing the benefits of the harnesses appeared in several Kenyan and international publications. As a result, the Department of Engineering of the University of Nairobi acquired a national and international reputation relating to animal draft power which lasts to this day. Since there was no local supply of such harnesses, a fabrication facility was established within the Department and people from several parts of the country were also trained to make them. As word spread of the success of the so-called "UniDib" collars (University of Nairobi - Dibbits), technicians from Zimbabwe and Zambia were sent to the Department of Agricultural Engineering to be trained how to make the collars.

Following the departure of Mr Dibbits in 1985, members of staff of the Department continued to promote the collar harnessing systems through demonstrations at agricultural shows and through collaboration with interested organisations. The technology was retained without significant changes. The long-term Dutch Lecturer, Mr Oudman, assisted by some technicians and harness makes developed an extension programme, the Animal Draft Power Project that operated mainly in Western Kenya. This project received some inputs from the Dutch support to the Department and additional funds from a Netherlands foundation and the Blue Eagles foundation. The

project, which is on-going, worked with co-operating NGOs and church groups. In Homa Bay District, six special demonstration farms were established (District Demonstration and Contracting Units or DDCUs) and more are planned. Along with promoting harnessing technology, the DDCUs promote an "improved" ox yoke, weeding technology and Rumpstad equipment. Animal health care, notably spraying for tick control, was also promoted.

Most publications relating to the harnessing and other animal draft power issues have been based mainly on undisguised enthusiasm and anecdotal observations. There appear to have been no attempts by staff or students to undertake objective, replicated research relating to harnessing systems. Nor does it appear that any rigorous literature reviews were carried out. A prototype system for carrying slurry in donkey panniers was developed as a student project.

In 1990, two MSc students undertook studies relating to animal power implements. One related to a prototype sugar-cane stool remover, and the other a study of plow performance.

In 1992, KENDAT (Kenya Network on Draft Animal Technology) was launched as an NGO aiming to develop animal power in the country. Since its formation, its Secretariat has been located within the Department, benefiting from Dutch-funded equipment. Its Chairman is a member of the Department (Dr P. Kaumbutho). In 1992 it held a national workshop supported by Netherlands' funds. In 1995 it held a second national workshop (supported by the British Overseas Development Administration) and hosted a large international workshop under the auspices of the Animal Traction Network for Eastern and Southern Africa (ATNESA).

Since 1992 there have been some attempts by staff members to undertake some objective research relating to animal power. Mr Owende is carrying out a PhD programme on the dynamics of animal drawn plows. Dr Kaumbutho, in collaboration with Dr Gebresnebet of Sweden, has been starting to obtain and or develop instrumentation that could be used to measure the performance of animals and implements.

2.4 Networking

Members of the Department have contributed to, and benefited from, several national and international networks. These have included the Kenya Society of Agricultural Engineers (KSAE), the Society of Agricultural Engineers in Southern and Eastern Africa (SAESEA), the Network for Agricultural Mechanisation in Africa (NAMA), Programme on Agricultural Operations Technology for Small Holders in East and Southern Africa (AGROTEC), the Kenya Network on Draft Animal Technology (KENDAT) and the Animal Traction Network for Eastern and Southern Africa (ATNESA). Several staff members have been office bearers or key people within these organisations that all aim to improve linkages between people and organisations and to enhance professional standards and capacities.

2.5 Staff & students

The achievements in relation to staff development can best be summarised in the following Table 2.

Table 2 *Staff trained*

1.	Mungai	Short course ICRISAT
2.	Mwaura	MSc Dublin State + PhD

3.	Chuaga	MSc locally / no longer employed
4.	Muchiri	PhD study in India/Wageningen
5.	Some	MSc UK PhD
6.	Gumbe	MSc UK PhD Ohio State University
7.	Gichuki	BSc-PhD Utch. State University
8.	Mungai	Siboe 1980 BSc MSc PhD Michingan State
9.	Serem (1990)	MSc Canada, PhD S McGill
10.	Maende	UK, PhD
11.	Owende	Dublin, PhD
12.	Kambutho	PhD Michigan State University
13.	Muni	PhD study Colorado State University
14.	Muturi	PhD study, UK
15.	Butek	PhD USA (no longer employed)

Not through Netherlands support

16	Biamah	busy on PhD in Wageningen
17.	Inima	?
18	Marenja	MSc in Kenya

About half the staff members had completed their studies by the beginning of the 1990s. It was by then that a critical mass had been established.

The following Table 3 specifies the students that have been trained. Comparing this output with the figures obtained for JKUAT and Egerton (resp. 40 and 100 BSc), it can be observed that this Department is the smallest of the three. Female representation in the BSc course with less than 3 % is insignificant. In the MSc course this is about double.

2.7 Infrastructure & equipment, etc.

The Netherlands Government support expanded the Department's teaching and research facilities. It specially funded the following:

- Three floor Agricultural Engineering building with classrooms, staff offices, Documentation Centre and computer room.
- Three laboratory wings to accommodate the soil and water laboratory, processing laboratory, wood workshop, metal workshop, tools and equipment store, farm power workshop, material store, farm machinery workshop and shed, and the draft animal power workshop.
- A wide range of teaching and research equipment for the above workshops.
- motor vehicles and tractors.

Table 3 *Students trained at the Department of Agricultural Engineering UON*

Year	Undergraduate BSc		Graduate Diploma		MSc
	male	female	male	female	
1978/1979	6				
1979/1980	11		11		
1980/1981	16		2		
1981/1983	29	1	3	1	
1983/1984	16				
1984/1985	5		5	1	
1985/1986	14				

1986/1987	22				Intake - 8
1987/1988	21	2			
1988/1989	20				Intake - 10 Fail- 1
1989/1990	35				Intake - 14 Fail-1
1990/1991	25	1			Intake - 5 Fail- 1
1991/1992	24	1			Intake - 25 Fail- 5
1992/1993	27	2			Intake- 8 Fail- 1
TOTAL	280	7	21	2	Intake - 78 out of which 5 female Fail- 9

This information is given as a matter of fact. Within the context of this review there is no time to assess the needs for infrastructure, equipment, etc., and by consequence, no comments are given except in § 7.3 on available equipment in relation to the sharing of equipment with the Faculty of Engineering.

At this point the conclusion could be that project has achieved its short-term objectives quite reasonably. Through the production of 375 graduates it can be expected that also the long-term objective has been / will be met.

The review could have gone deeper into the details of all these achievements. Collect more quantitative and qualitative data to substantiate this satisfactory conclusion.

However, the review team decided that the proper evaluation of this project, and especially its long-term objective, can only be achieved if it is placed in the wider context of the changes in thinking about agricultural research, extension and technology development over the past two decades.

This context is given in the next chapter 3, after which the achievements are assessed in chapter 4.

3 THE CHANGING ENVIRONMENT FOR AGRICULTURAL RESEARCH, EXTENSION, TECHNOLOGY DEVELOPMENT

This chapter reviews developments in (i) agricultural research, (ii) extension and (iii) education in Eastern Africa over the past two decades. Although discussed separately for matters of clarity, it must be understood that these three processes are intimately interlinked. The project, to be effective and efficient, should be in line with recent developments in agricultural research, education and extension thinking. It should therefore have addressed smallholder production - 80% of Kenya's agricultural production.

3.1 National agricultural research programmes

In the East African region, important developments in national agricultural research took place during the past decade. Predominantly instigated and co-ordinated by the WB and assisted by ISNAR, the reorganisation of agricultural research dramatically changed the research scene.

Since their start, the implementation of the national agricultural research programmes such as the National Agricultural Research Organisation (NARO) in Uganda, the National Agricultural and Livestock Research Plan (NALRP) in Tanzania and the National Agricultural Research Programme (NARP) in Kenya, suffered from a variety of fundamental constraints. All agree that problems encountered in smallholder production are complex. Solutions or recommendations should, therefore, deal with a variety of spheres, often at different levels of scale and analysis. Research in the different components of the national programmes, thus, must be multi-disciplinary. Creating such teams is itself complicated. First, most scientists usually tend to consider their own discipline as primary. Second, agricultural scientists argue that their discipline is already interdisciplinary and thus little need exists for adding other specialists to teams. Third, there usually is a presumed difference in discipline status. Some observers tend to conclude that the more expensive the hardware needed by a discipline, the higher the discipline status. In agricultural research, status ranking has genetic research and biotechnology as well as high yielding variety research on top. These are followed by agricultural economics and farming systems research in the middle. At the very bottom are farmers' knowledge and the relation between scientist and farmer, let alone on-farm research in which the farmer is involved.

Western agricultural production methods produced farmers specialised in crop monocultures or livestock. Western agriculture education taught that with the application of technology, natural constraints could be conquered. In this Western vision, nature was not an obstacle to economic development. Inadequate technology and cultural traditionalism were. Such an approach was basically successful where good soils were available and massive inputs into agricultural production could prevent major environmental and harvest degradation. This tradition led to specialisation and de-linking of agricultural services such as research, education and extension. It was exported through training.

Senior scientific and extension staff in the Eastern African countries has generally trained along strictly disciplinary and in-depth scientific techniques. Training is usually abroad and out of local context. Frequently, it is not at institutions that are involved in thinking about discipline integration or that had experience with smallholder production systems.

In the East African production circumstances, nature's determinism is difficult to ignore and farmers tend to attach predominant value to reduction of risks, instead of

maximisation of yields. The soils are generally poor and fragile, the climate is erratic and access to resources is usually limited. Agricultural research and related activities are now formally there to serve small holder peasant farmers who have to produce in circumstances that are entirely different from those in Europe, America or Asia. This farmer needs assistance in improving his complex farming system in total. Education in technology development has not yet come to aid the farmer.

The East African smallholder farmer cannot easily rely on a mono-culture. (S)he needs intercropping systems, alley cropping with productive trees and livestock to support the family. (S)he also needs cash crops as well as subsistence crops. All these should be integrated into a farming system that optimises the use potentials of the economic and natural resources without destroying the latter. (S)he needs facilitative appropriate technology to sustain production. Often such a perspective is lacking within the different agricultural services and donor supported projects.

The very fact that small farmers in the region did not perform according to the expected Green Revolution (see § 3.2), forced researchers to try to understand the way the small farmers behave and manage their farms. Research had to understand relations between different production factors and the difference between producing for market or for subsistence. Farming Systems Research was introduced, first as an analytical tool in the seventies and later on, in the second half of the eighties, with a much more important place for the knowledge and the participation of the farmers. This has triggered important changes in the set-up and approach of agricultural research in the region.

It has become clear the essential pivot in smallholder oriented research or extension activity should be the Farming Systems Approach (FSA). It started by developing Farming Systems Research (FSR) as one of the many programmes in parallel with other factor/commodity programmes (CIMMYT was ahead in using such systems approaches, but was still commodity oriented).

Lately, under pressure from the WB (!) and bilateral donors, FSR was transformed into a basic concept in all agricultural research and development.

Reorganisation of staff training is being considered in national agricultural research programmes. No longer should training be haphazard at assorted specialised institutions abroad, but according to well-organised and clearly focused national schemes where applied and interdisciplinary agricultural research is stressed. Such training emphasises modular on-the-job training based and alternates practical exercises and theoretical parts, with feedback from one module to the other. Some programmes stress the production of BSc staff arguing they are adaptable and, hopefully, still farmer oriented.

The Netherlands has reconsidered its technical assistance (-TA-) to national agricultural research in Kenya. Under NARP Phase I, TA was technology specific. In Phase II, the leading back-up is given by the FS oriented Royal Tropical Institute (KIT). Technical (subject matter specific) assistance will be subordinate to this FS approach. Similarly, in Tanzania, the Netherlands Government is supporting the establishment of FS teams all over the country to become the basis for smallholder agricultural development.

3.2 Extension; T&V system versus Participatory Technology Development (PTD)

The Green Revolution stressed high yielding varieties, high inputs, and mechanisation. Smallholder subsistence production was a temporary 'problem' that would be overcome soon. Relatively, it succeeded in parts of Asia. It has failed totally in sub-Saharan Africa where agricultural production per capita is falling. The majority of sub-Saharan farmers use very little external inputs like mineral fertilisers. The bulk

produces exclusively with locally available mineral and organic nutrients. This majority of small farmers did not accept the recommendations the commodity and factor oriented research stations developed, nor the equipment, implements and structures promoted by agricultural engineers, who worked on the basis of the same premise of intensification and mechanisation. These small farmers produce more than 80 % of the cereal production of sub-Saharan Africa.

Quite a number of aspects of agricultural development thinking are going through a phase of change. This can be summarised in a schematic overview as Table 4. It presents the different perspectives related to high or low input that agronomists can choose from when analysing rural and or agricultural development. The choice of a perspective has crucial consequences. Not only for research, for extension approaches, for relations with farmers, but also for choices of technologies to be further developed. Specifically, the technical aspects of low external input technology and production in low potential areas still require substantial attention.

Table 4 *Differences in looking at agricultural development*

Perspectives of looking at LEI(S)A agriculture		Green Revolution approach
Current share in cereal production in sub-Saharan Africa:	about 80 % in practice	about 20 %
Farming systems seen as:	comparatively diverse	rather uniform
Farm scale:	small-medium	medium-large
Environmentally seen as having:	comparatively high diversity	low diversity
Technology development:	'marriage' of indigenous and outside	brought in from the outside and adapted
Technologies offered:	Choices for the farmer to select from	Specific researcher-determined recommendations
R&D approach:	on-farm and on-station; baskets of choice	on-station; evt. on-farm demonstration; packages of practices
Scientific approach:	integrated and holistic; farming systems	reductionist; operational approach
Extension approach:	technology development joint effort of research, extension and farmers	transfer of technology
Extension system:	PTD	T&V
Planning:	bottom-up	top-down
Policy goals:	enable sustainable agriculture and conserve natural resources; maximise small holder diversification	maximise (output of) specialised production of commodities
Output:	food crops/cash crops	cash crops

The main extension system, in Africa, is the Training & Visit (T&V) system, being the climax of commodity related extension. It follows the targets of economic and land use planners and it builds its strength on concentration by its extensionists on one or two main crops. In theory, the same farmer is visited by various extensionists, all with disciplinary messages without complementarity or synergy. These numbers of extension staff draw heavily on national financial resources. Their budgets are shrinking.

Growing understanding of the complexity of smallholder farming systems and the recognised need to use local resources, have created new links between key actors. This was incubated within NGOs outside the 'mainstream'. Some extensionists worked in close relation with small farmers, and some individual researchers. Much more reliance on farmers' knowledge was essential to this development and joint on-farm trials on alternative ways of growing crops, keeping animals and using technology came into existence. A more participatory way of technology development emerged in which applied research and extension are strongly interlinked, if not integrated. This new approach to extension and research is 'Participatory Technology Development' (PTD). This approach is in strong contrast to the traditional way of agricultural engineers (see § 3.3).

It is defined as activities aimed at, or resulting in a *change of the existing technology* in a direction that is considered desirable by the different users of that technology (mainly farmers) and which are carried out *by networks in which the users of the technology play an active role*. In practice, a logical framework of activities is to be carried out in PTD. These can be presented in a schematic form:

Get started

- Build up relations of confidence and lay a basis for co-operation in analysis.
- Analyse existing environmental situation, farming systems, problems, networks (PRA or RRA, etc.).
- Establish relationships with existing networks or form networks for PTD.

Finding things to try (also part of PRA's)

- Take stock of indigenous technical knowledge and formal knowledge.
- Screen possible experiments related to varieties, soil/water systems, indigenous processes, tools, techniques and structures.
- Select experiments.

Trying out

- Assess and develop experimenting capacity.
- Choose subject.
- Ensure farmers have a choice of technology options.
- Design dynamic operational plan for experiments.
- Manage the experiment (could be on-farm as well as partly on-station).
- Assess the results.
- Analyse and understand the experimental process.

Sharing results

- Carry out extension (farmer-to-farmer and otherwise).
- Carry out training in use of new technology and in methods of PTD.
- Produce communications and training materials.
- Ensure relevant producers and services.
- Ensure input supply.

Sustaining the process

- Create favourable conditions for peasant organisation, local institutions, policy-level support, physical infrastructure.
- Repeat the process.
- Analyse and document the process.

The above description is very brief but it indicates main lines of recent developments. FSR as well as participatory approaches are coming into the 'mainstream' of development of small scale agriculture in Eastern Africa. It is against this background of developments in small farmers' agriculture that the mission analysed the performance and the relevance of the project.

3.3 Training at Universities for Agricultural Engineering

In the field of agricultural engineering, much "research" in the region in the 1960s and the 1970s involved the development of prototype equipment at Universities and on research stations. Conceptualisation, fabrication and testing were generally carried out by the engineers alone and once it was judged satisfactory, the extension Department was encouraged to promote the new prototypes. Throughout the region, engineers designed their own seeders, oil presses, toolbars, "improved" stoves, grain stores, biogas digestors and maize hullers. Almost all failed to be adopted. The engineers generally blamed poor extension and reluctance of companies to market their products. A classic example was the animal-drawn wheeled toolcarriers. At least eight different original designs were invented in Eastern and Southern Africa alone, and on-station trials were carried out in all the countries in the region. However, these implements that have been "perfected" by the engineers on research stations were conclusively rejected by the farmers. These implements that had been considered appropriate and profitable from the on-station work were found to be technically and economically in-appropriate in the reality of the smallholders' farms.

The perception that important changes are to be made has not yet reached the third side of the triangle, the training institutions, in a similar degree as it has the national research and extension systems. One of the crucial constraints in changing these research and extension systems is the attitude of staff involved, which is a direct result of how and where they have been trained.

As far as the review team knows, there exists only one focused effort in East Africa to change this top-down and on-station attitude in the field of agricultural engineering. It is the AGROTEC programme "Agricultural Operations Technology for Small-Holders in Eastern and Southern Africa" covered Kenya, Lesotho, Tanzania, Uganda, Zambia and Zimbabwe. AGROTEC is financed by SIDA and was executed by UNDP/OPS (now by FAO) which subcontracted the International Rural Development Centre (IRDC) of the Swedish University for Agricultural Sciences for the recruitment of professional staff to the regional office or AGROTEC secretariat.

The ultimate goal or development objective of the programme is described as "increased food production in the AGROTEC region through improved productivity and production in the small scale farming sector". According to the programme, this can only be achieved through improved farming systems and/or better farm operations technology. A change in the attitude and approach of agricultural engineers was recognised as a main overall objective

Although the objectives and the perception of the project are correct, an evaluation in 1994 concluded that the project's impact was insignificant predominantly due to managerial and organisational flaws. The Department of Agricultural Engineering of the University of Nairobi participated in the AGROTEC project.

4 ACHIEVEMENTS IN THE WIDER CONTEXT OF CHANGES OVER TWO DECADES

4.1 The dilemma

From the previous chapter 3 it became clear that considerable changes took place in the thinking about agricultural production. The top-down, high tech and high input ('Green Revolution') approach has gradually been replaced by participatory options. Since the concept of the Department is basically similar to the one in 1976, gradually the dilemma emerged: either to cherish academic freedom and pursue academic standards and interests exclusively (which was compatible with the 'Green Revolution' thinking), or to become oriented on the real needs of agricultural production.

The Department apparently made the implicit choice to continue as started. This was reinforced by the freedom of choice for the PhD study. All staff did their studies abroad with a heavy concentration on mid-western American Universities. These Universities as Ohio and Michigan State Universities were purposely established to satisfy the needs of large scale mechanised farming in the USA.

Considering the long-term objective the donor adheres to the project, and considering that smallholder production represents not a thing of the past but the mainstay of present and future agricultural production, the team thinks that the donor would opt for a development and smallholder oriented approach at the Department. In that respect it is remarkable that the donor or the expatriate staff continued in accepting the total freedom of choice for PhD training abroad (in the USA) and choice for MSc theses. As stated in § 1.3, it is laudable that the 'ownership' was left with the Department, however, when this leads to developments that will make the long-term objective nil and void, at least a serious discussion between Department and donor should have resulted (see also § 7.3.4).

Despite review missions and expatriate input, the project lacked a 'learning mechanism' and remained shielded in the comfort of its ivory tower while the outside world was changing rapidly and substantially. The team thinks that the Department is hardly to blame for this. The critical mass at the Department was not established until the 1990s and the learning mechanism should, in the meantime, have been provided by the external input (it is not the individual expats who are largely to blame, since they were selected and mandated for a restricted role; essentially as additional teaching staff while future staff was abroad for training. In § 7.3.4 it will be described how the donor lost track of the long-term objective a long time ago.

At the time when that critical mass existed and the first attempts were made by the staff to start strategic thinking, the donor decided to phase out. This was poor timing and damaging to morale.

4.2 Curriculum and human resources

It appears it has become the tradition of the agricultural engineering Department to get more theoretical and ignore socio-economic courses. A review of 1987 B. Sc. curriculum with 42 possible courses and the 1991 B. Sc. curriculum with 79 possible courses supports this contention. At the same time there has been less and less time for practical work. This practical work would have been essential for at least (some) farmer orientation.

The 1991 BSc curriculum had only 10% of the courses outside what are in essence engineering courses. This is a reduction of 4% from the previous BSc curriculum! The courses that constitute the 10% are: 1. Fundamentals of Development and their Application to Kenya 2. Element of Philosophy 3. Communication Skills 4. Statistics and Experimentation 5. Operational (sic) Research 6. Principals of Animal Production

7. Farm Management and Agricultural Extension and 8. Engineer in Society. It is worth noting that the economics course was dropped! Further, it should be noted that the Department did not avail the mission with course descriptions and thus it is not possible to comment on what the strange mixture of courses covered. It is though doubtful that many matters of import to smallholders and their production were covered in these courses.

The MSc curriculum has 91 possible courses. Only 3% are non-engineering! These are Project Planning, Statistics and Experimentation and Social and Physical Ecology. Perusal of their descriptions confirms strongly that matters related to smallholders and their production systems are not systematically covered.

4.2.1 Relevance

In terms of how the programme is related to the long-term objective of improving smallholder agriculture, we believe this could only have been achieved by building into the undergraduate and graduate programmes active involvement of the students and staff with smallholder farmers. In other words, by structuring more field activity. The omissions were made by the three parties involved in the project: the Department, the Donor and the review missions.

Opportunities were lost in terms of discussing how the BSc and MSc programmes related to the long-term need for the project to address issues of smallholders. Although the 1985 mission called for more practical orientation in the BSc programme, there was no detailed discussion on the curriculum especially in relation to the introduction of the 8.4.5. system after 1989. There has been an increase in the number of theory courses. Staff members agree on this point. Issues of how much practical training, which would be farmer oriented, could be put into the BSc curriculum were not addressed by the Department. It assumed that the BSc would be a good platform for the MSc. Therefore, there was no exploration of how farmer oriented training could be structured at the BSc level to feed into the MSc level through those who graduated into it. There was no attempt to state the demand for agricultural engineering in this sector then or later. The 1985 review exclusively focused on justifying the MSc programme.

The 1990 Mission was interested in streamlining the MSc programme although its terms of reference specifically called for judgement on how the project showed:

- “concurrence with latest knowledge/ideas”, and
- “to which extent are students apart from necessary technical subjects exposed to such non-technical subjects as farmer involvement and attention to socio-economic issues prior to project implementation?” and
- “to which extent is the education programme in agreement with the actual work the students are expected to do after finalisation of the study?”.

It seems to this mission that all parties have brushed aside the issue of farmer oriented practicals by focusing on how the Department can supervise the students after they leave the campus to facilitate their certification. If the option of increasing much more practical training was taken for both levels early, then it could offer a way out to the certification problem. The mission does not see how the Department can become the supervisor of products employed by others to enable them to be certified.

It is a summary point then that the donor did not pursue the issue of long-term contribution to the smallholder sector for it would have raised it with the Department, the project coordinator or even the past missions.

4.2.2 Level of training

Evidence presented to the mission suggests that the project has contributed to overtraining and thus militated against the interests of smallholder farmers. The first issue is how the project dropped the Post Graduate Diploma course and went into MSc training.

A first note is that two Dutch funded projects seem to have been responsible for pushing for higher level training. The Smallholder Irrigation Development Project, in the Ministry of Agriculture by 1977 had 12 Dutch TA, many of who were in line positions. Those running this project and those at the university, in keeping with Dutch ideology, saw the need to *produce personnel to service other Dutch projects*. The 1982 Mission, the first external one, stated that "The funding of the Department was consistent with need to train professional manpower as counterparts for other Netherlands funded projects in Kenya." This fact was clearly articulated in 1980 when there was a proposal to discontinue funding the project. From the project document it would appear that Netherlands experts in the Faculty played a major role in its formulation. The reference here is to the Netherlands TA that was in crop science and which also spawned the Department of Agricultural Engineering.

It should be noted that Dutch TA to the SIDP had grown to 25 in line operations in the MoA by 1983. Thus, when the 1982 Mission argued for replacement with local highly trained personnel, it hit a chord. Many Kenyans saw jobs in replacing Dutch TA. It fed on the initially BSc level staff training to come to the line operations of the ministry and later the post graduate diploma. This fitted the interests of the Kenyan MoA officials who were looking for advancement through training first, and then replacement of the Dutch. The two sides generated the pressure which by 1983, when there were 25 Dutch TAs in the MoA, began to build for training at the higher level to reduce the TA as well as generating university lecturers.

This objective was achieved by 1985, essentially through the post graduate diploma. By 1985, Dutch TA had been reduced to 12 and by 1994 to 2. The SIDP concluded in June 1995 without a terminal evaluation.

The MoA is desirous of such an evaluation for it would assist it in evaluating overtraining.

Perusal of the 1985 Mission report also shows that Dutch TA in the SIDP, Dutch TA at the University, Kenya University staff and MoA staff trained under the project were arguing in support of the MSc, without establishing a national demand for it. Staff at the MoA, who were junior staff then, argue that the MoA in general did not support the establishment of the MSc programme. It should be noted that these senior managers now came into the project through the post graduate diploma. Their previous work had been in extension in the MoA and they are thus partisan to the field extension approach.

The second issue is the current problematique of staffing at the MoA Land Management Division especially. This Division was essentially created out of the Dutch funded SIDP. Senior managers there argue that idealised 1995 demand for Agricultural engineers is 317 staff. Current staffing is 142 (see the following Table 5).

It is worth noting that the 1982 Mission established that the percentage of BSc graduates who were in the MoA was just over fifty. If parastatals are added to this, 64% of all graduates were in public service. This compares to the 142 currently employed by the MoA out of 375 trained both at the B. Sc., Post Graduate Diploma and MSc. In other words, 38% of all those trained are in the MoA. On the other hand if one counts only the BSc graduates the 142 figure is just about 50% of the total 287 produced to date.

It, however, should be noted that over the past four years, the MoA has only been authorised to recruit a token number of the graduates. During 1995, it was only authorised to recruit not more than 10 out of the projected output of about 120 from Nairobi, Egerton and JKUAT. Thus, only about 8 % of this year's graduates have a chance for public sector employment.

Table 5 *Employment opportunities at the MoA*

<u>Idealised demand by the MoA</u>	
Irrigation	120
Soil and Water	70
Mechanisation	31
Rural Technology Centres	
Agricultural Extension	61
Coffee Factories	27

Total	317
 <u>Staff in place at the MoA</u>	
Soil conservation	20
Irrigation	68
Mechanisation	30
Rural Structures	24

Total	142

These statistics are only presented to firm up an argument that there is perhaps an oversupply of university trained agricultural engineers from Nairobi. At the same time there is a shortage of agricultural engineers at the Diploma and Certificate level.

The shortage at diploma level is related to the first project decision to train at university level. Egerton followed with pretty much the same curriculum. Significantly, it stopped the diploma course to give the BSc similar to Nairobi. Jomo Kenyatta UAT first graduates hit the market this year. The shortage in MoA at the Technical Officer level has become so serious that three years ago, GoK made the decision to start training at that level at Bukura. Since the MoA cannot recruit new staff, it is forced to recruit such trainees from the certificate holders in payroll. *This practically means that the technical extensionists are being depleted.* Smallholder farmers are losers in this operation.

Limited interviews in the private sector and the NGO sector also suggest that there has been overtraining. In an interview with a BSc working for Unilever, he argues that together with his other two colleagues in the company, the training is essentially general education for they are salesmen. Of course it is useful. Their classmates are an academic, a draftsman in an engineering firm and a small business consultant in non-engineering activities.

One NGO, which employed a BSc graduate, argued that they employed him because he did some extension with the MoA after doing the BSc. They bought the extension, not the engineering.

4.2.3 Planning

In Politics, Economics and Technical Training, a study of technical training in Kenya, (Nairobi: Kenya Literature Bureau. 1979, E. M. Godfrey and G-C. M. Mutiso) it was concluded that "...the private rate of return to academic education beyond certain levels

has fallen, in relation to the private rate of return to technical training, to such an extent that technical training has for the first time become an attractive proposition." (p.21). This conclusion captured the tenor of the times when technology was supposed to save the country. Agricultural engineering was part of that saving bundle of technologies. Has it now gone the route non-technical education?

Data from interviews and previous missions suggest that the initial training in BSc and the Post Graduate Diploma course was extremely useful. It generated staff to replace Dutch TA. It generated a platform for selecting for staff training. It was extremely useful to some in the private sector as background to other activities. All these may be indirectly of importance to smallholders but it will be hard to systematically show how they relate to improving smallholder production. The fact that many go unemployed now is evidence of non-relevance of the training.

The team was informed by the MoA/Department of Land Management that GoK/MoA had to reintroduce diploma training at Bukura. This is prima facies evidence that demand for this level trained personnel is there. It raises the question why to create a top heavy pyramid. In the study cited above, it was concluded that the most serious shortage of technical personnel at the national level was at the diploma, the middle level. Other general personnel studies have made the same conclusion. Bukura diploma training recruits at the employed certificate level staff. This depletes extension staff who is in contact with farmers. It means that bureaucratic activities will continue to be done without effective extension. Since the country has very limited non-public sector extension, it is doubtful whether other agricultural engineering staff will have contacts with smallholders.

The hard conclusion is that if the project obeyed the spirit and letter of its long-term goal, it should have supported more extension activities and perhaps training at the diploma level. The forces who cohered to argue for the MSc degree in 1985, without doing a national personnel demand, have contributed to the negation of the long-term objective. Now even the few extensionists are being drawn into administrative bureaucratic levels.

4.3 Research, theses and other publications

The Department has long been aware that it has not had a clear research strategy. It has made attempts to formulate a research programme, most notably at the 1991 Masinga workshop. This led to a long list of possible research topics, many of which were vague and most of which have not been touched on. A Research Committee has been formed, but the Department is aware that it has not been operating effectively.

What has been written in § 4.1, is highly applicable to the research. Research is selected on basis of individual / academic preferences without any overall departmental strategy let alone taking into account the position and constraints of smallholder farmers.

The latter statement can be analysed from the theses' titles (see Table 1). Out of the 41 theses' topics, only seven could bear direct (## 9, 10, 11, 14, 24, 25 and 28) and two (## 7, and 30) possible relevance to the smallholder production sector. The far majority of 35 titles bear no smallholder relevance.

It is normally very difficult for people to change their thinking without some outside support. Such support or guidance was apparently not given.

4.4 Draft Animal Power programme

For over 10 years, the Department has been actively promoting the "UniDib" collars for oxen and donkeys.

The ox collar does not appear to have been adopted by farmers anywhere in Kenya. It has also been rejected by farmers and projects in Zambia and Zimbabwe.

People employed by the Draft Animal Power Project to promote the ox collar on the demonstration farms in Western Kenya had only been told of its advantages and they were not aware of its complete lack of adoption during the last decade of promotion (although they were well aware that farmers in their own areas were not using it). What is more important, none of the extensionists interviewed was aware that there existed simpler alternatives to the single ox collar, such as the single withers yoke.

Despite the lack of adoption, there appear to have been no attempts by staff of the Department to record and analyse experiences relating to these harnesses. Thus, the only publications on record are the initial optimistic ones. Staffs of the Department have not objectively investigated and recorded the comparative advantages and disadvantages of the various harnessing systems. The promotion of these ox collars is still on-going in 1995-96, despite inevitable erosion of the credibility of those promoting them.

The situation with the donkey harnesses is similar in many ways, although there has been some patchy adoption of these by farmers. In most cases, where there has been some adoption, it has been as a result of an NGO providing the harnesses either free-of-charge, or as part of a package. This is true of similar, low level adoption in other countries in the region. In most cases where farmers have adopted the donkey collars, they were not offered the alternative of a breast band harness. Breastband harnesses have been widely adopted by farmers throughout Africa, but they are little known in Kenya. Those responsible for demonstrating the collar harness on the Animal Draft Power demonstration farms did not know about breastband harnesses and did not have samples to demonstrate this (widely accepted) alternative to the innovative design being promoted. Only in the last year, has KENDAT stated to include breastband harnesses in its options for farmers, following collaboration with KSPCA in Limuru.

The methodology used for promotion of harnesses (and other technologies) has been based on the top-down extension approaches that generally failed in the 1960s and 1970s. In Homa Bay District, in particular, the establishment of demonstration farms to promote technologies selected by researchers, is highly reminiscent of the failed rural technology centres found in most countries in the region (including Kenya and Tanzania). It has been clearly established that such demonstration farms allow extensionists demonstrate inappropriate technologies year after year, with little chance for learning or constructive feedback. They also tend to be gender-biased and ignore crucial socio-economic aspects of the local farming systems.

All recent successes in animal draft power technologies in the region have come from on-farm evaluation by farmers themselves using technologies selected by the farmers from a range of options offered by the researchers. Examples of such participatory technology assessment and or extension have been seen in Zambia (Palabana), Tanzania (Mbeya and Tanga) and to a certain extent in Kenya (DAREP, Embu). Reports of these have been available internationally in the past few years, notably through the Animal Traction Network for Eastern and Southern Africa (ATNESA).

Besides harnesses, the Department and the Animal Draft Power Project have worked with a few other technologies besides including carts and most recently the Rumpstaid toolbar. Although there have been some differences in the technologies and the uptake, the methodology has been similar. The tendency has been to offer single prescriptions rather than options. There have not been detailed and objective evaluations of the technologies and the Department has not systematically worked with farmers on their

own farms to allow them evaluate the technologies. Thus, the Department has missed valuable opportunities relating to research, technology development, extension and teaching.

With this in mind, it seems particularly ironically that at Limuru, about 12 km from the Kabete Campus, there has been no obvious impact of the past decade of work relating to donkey harnesses in the Department. The neck harnessing systems widely used there appear to be inefficient and in some cases cruel. It seems it would have been an ideal location for participatory research with local farmers and transporters, in order that an efficient, affordable and acceptable harnessing system could be developed and adopted. Whatever the success (or failure) of such work, the technical and socio-economic problems encountered would have provided much valuable material for student projects, and for teaching about the reality of agricultural engineering problems in Kenya. In the last year, KENDAT has started to work with KSPCA in Limuru, and this appears a positive move that should benefit the Department.

On a more positive note, while attempts by the Department to train and assist harness-makers to establish viable businesses have not been very successful, this has been mainly due to low product demand rather than the methodology adopted. The training of harness-makers has illustrated that the Department has given significant attention to the problem of ensuring a sustainable supply of the new technology. Such supply-side concerns have often been neglected by other organisations promoting innovations.

Another very positive recent development has been the formation of KENDAT, which although it is an independent NGO, is currently co-ordinated from the Department, and it has benefited from the support of the Netherlands' project. KENDAT started with the rather out-moded ideas and methodologies that have been prevailing within the Department in the last decade (uncritical promotion of so-called "improved" yokes and harnesses). However, the national network is linked to the international network (ATNESA) and through workshops, publications and exchange visits, KENDAT has been learning of other experiences in the region, and of the importance of participatory methodologies. As noted, KENDAT now offers farmers / transporters a choice of harnessing options, not just one prescription. Furthermore, through KENDAT and ATNESA, the Department is now linked with research and extension programmes in several countries and with a number of world-class scientists and engineers. Such links have been largely missing in the past decade, and the prospects for the Department to live up to its international reputation in the field of animal power seem to have improved significantly in the past year.

In summary, work relating to harnessing in the Department started with much enthusiasm, but relatively little objectivity. Modest attempts at promotion based on non-participatory methods have continued almost unchanged since that time. The Department does not appear to have evaluated the technology rigorously nor has it analysed its own experiences critically. It does not appear to have kept abreast of current literature relating to either harnessing or to extension methodologies. In short, it has not made use of its acquired national and international reputation and its available expertise and contacts to provide professional leadership in this field. It is not too late for it to do so, and the recent formation of KENDAT, affiliated to ATNESA, has provided new ideas and impetus that could lead to a rapid improvement in the situation.

4.5 Staff & students

The majority of daily responsibilities in agricultural smallholder production are with the women, not with the men. On top of that, smallholder production is increasingly characterised by female headed households, especially in the ASAL areas. Many of the technological improvements and the relief of burdens in smallholder production are, thus, directly related to women. In that respect, the team observes a striking

discrepancy between the number of female students and the tasks the agricultural engineers should face (see Table 2). It must also be observed that none of the lecturers is female (JKUAT has two female staff, including one professor).

The reason for this male domination may be found in the combination of the 'engineering' curriculum that pays little attention to alpha-disciplines, and the fact that in Kenya very often separate high schools for boys and girls exist, where the female high schools pay less attention to beta-disciplines like mathematics, chemistry, etc.

Moreover, it should be observed that the intake and production of graduates and post-graduates is not based on any assessment of the requirements; the demand side has been neglected. Not only outside the University, but also inside, considering the favourable student / staff ratio.

This topic is discussed, concluded and recommended in more detail in the parts on curriculum development.

5 INSTITUTIONAL ASPECTS

The main institutional threats to the project and its orientation to have impact on production processes of the smallholder farmers are the Faculty of Engineering base, professional certification, equipment, and physical location.

Of a different but also institutional character, and highly relevant for the present situation, are the decision making processes that took place at the Department and with the Donor.

5.1 Faculty of Engineering academic base

The Department is caught between two stools. Its academic mother is the Faculty of Engineering. Its administrative mother is the Faculty of Agriculture. This means that its curricula and accreditation processes are controlled by the former. Naturally this implies that the emphasis in curricula and accreditation is seen basically in engineering terms. This tradition has been extended to the other two universities who have started departments of agricultural engineering. Egerton University essentially picked the existing Nairobi curriculum for this was easier than struggling to get the curricula accepted.

This influence is not just in terms of the structural arrangements of picking up an existing curriculum and implementing it. It is deepened by the personnel produced in the Nairobi system who have gone to the other universities as staff. They expand the Nairobi tradition. Nairobi graduates are found at Egerton University and JKUAT.

Faculties of Engineering are less tolerant of farmers, especially smallholder farmers, than Faculties of Agriculture.

We have not found evidence that the issue of academic base was ever raised by the donor. The Department staff is split on the issue. The majority seems to favour the current affiliation for they primarily see themselves as engineers. A small body of opinion thinks that they should be affiliated with agriculturists. What determines what opinion is held, seems to depend on whether the particular staff member came to agricultural engineering from engineering or from agriculture.

On balance, the opinion of the mission is that, from a national point of view, there is need for more farmer orientation over and above the needs of this project. This perhaps can only be assured by greater involvement with other farmer oriented departments found in the Faculty of Agriculture. Most of the Department's staff does not agree with this conclusion for they argue that they need the faculty of engineering to assure a certification.

5.2 Professional certification

In Kenya, one does not practice as an engineer unless one is registered by the Engineers Registration Board. This has career and income implications. The independent registration board, dominated by non-agricultural engineers, sets essentially engineering oriented criteria for certification. Thus, an agricultural engineer, who takes part in non-engineering concerns, is not fulfilling registration criteria. Like other professional boards, change comes slowly to this board. Hence the concern by staff that they assure that their products get certified by insisting on the engineering content in the curriculum, as well as by maintaining affiliation with the Faculty of Engineering.

5.3 Faculty of Engineering teaching equipment

To train students in the engineering component, the Department uses equipment of the Faculty of Engineering at the main campus. To date the Department has not acquired enough equipment to mount the courses on site. The mission has not found any formal document showing that the issue of providing the necessary equipment, independent of the Faculty of Engineering, was ever discussed. However, some of the old faculty members argue that it was considered and rejected at the beginning, 1976, for transporting students to the main campus was cheaper.

5.4 Student transport to the Faculty of Engineering

All students who have to take the engineering courses at the main campus, where the Faculty of Engineering is located, have to be transported. This is probably the major operational cost of the Department. Vehicles, bought and serviced by the project, have been the backbone of this activity. The university contribution to this activity has been negligible and is not likely to improve at project closure.

5.5 Decision making and team building by the Department

The Department is a relatively new organisation. It has grown very fast. Therefore, it exhibits all the organisational and managerial problems of a new organisation. Among these are lack of consultations, lack of acceptance of line authority, extreme individualist behaviour, lack of co-ordination, lack of agreed medium- and long-term strategies and suspicions. All these lead to extreme competition for recognition and status further militating against co-ordination, for all members are essentially age mates.

Problems of internal decision-making were recognised by both the 1985 and 1990 review missions. Both missions in different terminology called for changes in the management of the Department. One should though note that the solutions offered did not work for they did not address one of the key issues when an organisation has many conflicts. This is the issue of external facilitation, needed to let the organisation work through some key issues to build confidence in itself. Clearly the TA provided did not have these skills (they were not recruited to have such skills !), nor did they detach themselves from the Department to act as facilitators. Once an organisation solves a key problem, - in this Department the long-term research strategy or the revision of the curricula systematically fall into the key categories -, it builds confidence in itself to tackle ordinary problems.

The 1985 mission called for establishing guidelines on leaves of absence, changing teaching methods, setting national research priority areas, creation of a research committee, ascertaining transfer of knowledge methods to farmers, supervision of graduates in the field, networking, and training staff for other universities. Other than the last one, which was to happen whether the Department did anything or not, the other recommendations have not been acted upon by a process that includes discussion and consensus by the faculty members. Individuals have taken initiative on some issues and run with them.

The 1990 mission pointed out that the Project Co-ordinator prepares project proposals and reports and that they are sent out under the signature of the Chairman without much discussion by the other staff members. It also stated that research on animal power ought to take priority over extension for the scientific basis of the activity had not been established. Decision making on project funds was mainly done by the Project Co-ordinator and the Chairman. Operational expenditures of the Department were from the

project and the Department was supposed to look for alternatives. The Department was supposed to develop a comprehensive and medium to long term research programme.

Issues of participative consultations in decision-making for team building within the Department were central in the recommendations of the 1990 Mission. It pointed out that the Department should "begin evolving a permanent departmental process to:

- 1. Execute agreed departmental plans without seeing them as only derived from either the section heads, the senior scholars or the chairman personally.
- 2. Plan long term training, research, and contract consultancy strategy.
- 3. Manage conflicts arising out of competition for resources within the Department, particularly inter-sectional competition between the three sections, namely, Agricultural Power and Machinery, Agricultural Processing and Structures and Soil and Water Engineering".

To facilitate this, the Department was to formalise the Executive Committee, made up of the Chairman and the three section heads and to create two staff committees, namely Research Committee and the Education Committee. The mission advocated these committees for key decisions were made or are perceived to have been made without staff consultation. Staff consequently either fight the decisions or distance themselves from them. The case of animal draft was cited.

The Department duly created the two committees. The whole Department organised a retreat in Masinga in 1991 to pursue the recommendations of the 1990 mission, particularly those related to a long-term strategic plan. All members of the Department we have talked to argue the four-day meeting was a failure for they could not reach agreement. Moreover, since many staff members had not made preliminary proposals on research and extension of the project, the final document was seen as only the ideas of the Chairman of the Committee. The mission has been told by some members that they were so disgusted they decided it was up to the Chairman and the Co-ordinator to produce the document that went to the Embassy. Even more serious was the conclusion by some that it was the responsibility of some sections to work on it for other sections already had other donor money (from SAREC). This position still holds. Those so divorced now argue they have evidence that the other section could not develop a strategic plan that could be funded. The general opinion seems to feel that this Committee is moribund.

Again, in November 1994, the Department met to consider revision of the BSc curriculum that had been revised to cater to the 8.4.5. in 1990/91. A large body of staff claims this only added more theory courses, though they had invited farmers and other consumers of the Department product to the meeting. There was no systematic output on which all are agreed. Most staff members claim not to have seen the output. Perhaps the most serious evidence of lack of co-operation among staff is a request that they be paid to complete the revision of the curriculum.

Some in the Department explain the extreme lack of co-operation as a result of the aftermath of the University strike in 1992 when the state brutalised university lecturers in general. It is worth noting that inflation and devaluation in 1993 and 1994 seriously eroded the incomes of salaried employees, university staff included. This coupled with the negative response to the state's reaction to staff demands in 1992, among which was the issue of salaries, has led to general demoralisation. Many now have outside jobs or consultancies.

The problems militating against team approach enumerated above are real. However, this mission is of the view that in the situation of extreme uncertainty, which the country and the university underwent over the past three or four years, the organisations with systematic co-ordinated strategic plans are the ones likely to survive as entities. Of course some individuals in the Department are doing well for they have research money. Some have established good consulting practices. It should be clear to

all though that uncoordinated efforts, however important to individuals, do not lead to the survival of the organisation, the Department, which in the long term assures their welfare even in consulting.

5.6 Decision making by the Donor

The decision making process at the donor side is more difficult to evaluate. First, the files at the RNE do not cover the entire project period and in the second place, much decision making was done in a rather informal way and is not fully documented. This means that arguments used are often unclear or unavailable and that only the end product (like e.g. the Bemo or Appraisal Memorandum for Phase IV) is obtainable. This Bemo gives little or no indication which arguments and considerations have been used to arrive at the phase out decision. The Bemo is based on some general and rather optimistic assumptions that lack sufficient support.

Some examples of this are (Translated from the Dutch):

- The proposed project contains a sustainable reinforcement of the quality of the faculty, staff and facilities....(page 5, 1).
- After this, the faculty will have to be able to function independently....(page 5, 1.1.1).
- The proposed workplan already incorporates facilities to ensure continuation at the same level after termination of the Netherlands support....(page 6, 1.2.2)

Circumstantial evidence, however, makes it probable that the project has operated in the margins of the bilateral development co-operation package between Kenya and the Netherlands. In a rather systematic way was the project assigned to young and newly arriving diplomats, who encountered the project as one of their first experiences with development co-operation. Interviews on the telephone with some of these diplomats now stationed in places far away from Kenya, confirmed this impression.

The interviews also made clear that the project was looked upon as one of narrowly defined institution building. The project was about the administration of staff to be trained abroad, about expats who had to supplement lecturing capacity, and buildings and equipment to be provided. This implies that the long-term objective of the project seems to be forgotten a long time ago by the donor, at least by the middle of the 1980s. The character of the project was remembered as a 'topping up' one, where contents hardly played a role. It was in essence looked upon as an administrative project that was well organised and administered (that, thus, could be handled by diplomats with little development co-operation experience). It is no wonder that most contacts were between the expatriate staff and the financial administration at the RNE.

Also in the 1990s, when the decision was taken to phase out, the project was never really discussed - isolated as it was from the mainstream of the bilateral development co-operation effort. It just seemed logical in 1991, after so long a period, to phase it out, which decision was communicated to the desk in The Hague. Apparently the desk accepted and stated in the Bemo on top of page 3 that the project is one of the "programmes that no longer have priority in the regional development policies".

It must be observed that once this decision was taken, the phasing out was done in a proper, generous and patient way by the donor. Noteworthy is though that the character of the final phase was to prepare the Department for the future that would lack the support of the Netherlands Government.

In line with this character is the fact the last expatriate was initially supposed to phase out early in this final phase, after about a year. In the end, he remained several years longer, until the very end of the project. The related decision making is not transparent.

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END - OF - PROJECT REVIEW
UNIVERSITY OF NAIROBI/DEPARTMENT OF AGRICULTURAL
ENGINEERING (KE/92/030)

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1 PROJECT CONTEXT

1.1 The dilemma

The classic dilemma that was part of almost all the discussions the team had, was observed early in the project's implementation. It was nicely, and in a positive way, described in the 1982 review on page 13 (last paragraph) as a "creative tension". Yet, the warning in the last sentence that "the philosophy which the Department adopts will be vital in determining.... the commitment and ability to serve the rural smallholder ..." never played a role in project related decision making afterwards. This, despite the importance it carries in relation to the achievement of the long-term objective of the project.

Where one of the lecturers of the Department stated "... as academics, we are working in an ivory tower, and we are proud of it", others favoured the opinion that scientists / intellectuals primarily should focus on solving the development constraints of Kenya. This classic dilemma at institutes of higher learning is not unique for Kenya but a standpoint in this is essential for the evaluation of the project; without it, one cannot properly assess the impact and achievements of the 20 years the project was in operation. Is research and teaching at a University Department determined by academic and private standards and interests (the ivory tower), or is it determined by the needs of society, in this case the needs of the agricultural production sector in Kenya.

Following a review of the short-term achievements (in chapter 2), in chapter 3 the team will indicate the arguments it used to arrive at their point of view, which assumes to also be the donor's one. After which, in chapter 4, the achievements are reviewed considering the long-term goals.

In the same chapter 3, the team will describe the developments and the fundamental changes that took place in the thinking about agricultural production in East Africa; the transfer was made from high-tech, high input, and top-down 'Green Revolution' thinking to a participatory, farmer oriented approach. Especially for a project that ran for two decades an insight in this transfer is indispensable for proper assessment of impact and achievements.

1.2 Smallholder production

Essential also is the realisation that in Kenya (like in the rest of sub-Saharan Africa), the majority of agricultural production is generated by smallholder farmers. These produce both cash and subsistence crops, but subsistence cropping is still the pivot for food security, and even more so now when more and more of the food crops are grown in the semi-arid areas of Kenya.

Relevance of an activity for the agricultural production in Kenya is, to a large extent, determined by its relevance for smallholder (subsistence) production. For example, with smallholder production the aspect of power in the farming system is rather a matter of animal traction than of mechanisation / tractorisation.

1.3 Donor's policy

The donor should be commended that it left the ownership of the project with the Kenyan staff. Especially at the time when the project started, this was a novel attitude. The expatriates assigned to the project always operated as colleagues rather than as team leaders. That the ownership was very much with the Kenyan staff also transpires from the fact that only one of the staff went to the Netherlands (Wageningen) for his training,

although at that University in Wageningen, teaching and guidance can be done in English. A lecturer at the JICA supported JKUAT, on the contrary, had to live in Japan for six years to do his PhD, and spent the first year in learning Japanese. If this 'little-involvement' policy of the donor is ideologically to be applauded, it also had its negative consequences as will be made clear by this review.

Nevertheless, the overall loyalty demonstrated by the staff that were involved in the execution of the project, might be explained by the donor policy vis-à-vis the matter of ownership. However, it can be argued that the initial 10-15 years were for putting staff in place. Thus, another 10 year period could be justified to allow the staff to build up the institution.

Another important aspect of the donor's policy was the preparedness to accept a long-term commitment of 20 years. This is essential to arrive at successful institution building.

2 DIRECT PROJECT ACHIEVEMENTS

The total costs of the project mount up to the following (in NGL, according to the Department):

Phase I (1976-1981), commitment made	3,100,000
Phase II (1981-1987), commitment made	3,450,000
Phase III (1987- 1992), commitment made	4,770,000
Phase IV (1992- 1996), commitment made	1,600,000

Total	12,920,000

2.1 Curriculum development

The curriculum has been developed using the recommendations from previous review missions. The total result of changes can be studied in the Addendum to this report that contains a copy of all the curricula developed. This Addendum is of particular interest to the Donor and is, therefore, not part of the overall report but exclusively distributed to the Client (curricula on BSc, on BSc 845, on proposed changes, and on MSc).

In the 1987 curriculum for the three-year BSc degree, whose intake was A level students, only 14% of the courses could be interpreted as non-engineering. These are 1. Introduction to agriculture, 2. Economics, 3. Crop Production, 4. Animal Production, and 5. Farm Management and Extension. In this curriculum, practicals are conducted for the three years the students were on campus for three months every year. It was thus possible for a student to get nine months of practical work.

The 1991 BSc curriculum was developed to cater for the students who did not do A levels. These are the so-called 8.4.4/5 students. It was assumed that they did not get the extra two years preparation in the sciences to give them university level entry training. Consequently courses seem to have just been added: to fill the five years the students were to be at the University. For example, Thermodynamics courses increased from two for the BSc to four. That was not all. There is one course that clearly was a bow to the political powers that were then seeking loyalty from the University through the then Vice Chancellor. Similar courses were approved by him throughout the University. This course is titled Fundamentals of Development and its application to Kenya. Its utility is doubtful.

In the 1991 curriculum, practicals were reduced to only six months and spread into the second, third and fourth years. An opportunity for structuring real practicals in many sectors, smallholder sector included, was missed. This is more tragic given that many of the entrants to the university were coming from urban areas and thus the assumption that they understood the rural smallholder sector, which had been argued before, was increasingly untenable.

1985 Review Mission

This 1985 review saw its main task as not focusing on the BSc curriculum but on: "two main areas of future development...first was the need for a MSc programme ... second was the need for research and development" (p.2).

The programme involved offering "700 contact hours to the BSc Agriculture Engineering programme (and) 200 contact hours to the BSc Agriculture programme and 160 hours to the BSc Range Management Programme" (p. 8).

The 1985 mission recommended that the practical for the BSc engineering be expanded. It was further noted that the Post Graduate Diploma in Irrigation and Soil Conservation

was to be discontinued "since the same manpower requirements can now be met by graduates of the BSc (Agric. Eng.) programme." (p. 9). Therefore, there was need to get the MSc course started, for up to then those wanting this training were going overseas (p.10). Their research would be in Kenya and they can thus contribute to departmental research for "considering the heavy teaching load of staff members" (p.10).

"Agricultural engineering graduates will work on an MSc in Agricultural Engineering in one of the three areas, Soil and Water Engineering, Agricultural Power and Machinery or Agricultural Processing and Structures. The MSc Agricultural Engineering degree will be awarded by the Faculty of Engineering. Agriculture graduates will work for a MSc in one area only, Land and Water Management. The MSc Land and Water Management will be awarded by the Faculty of Agriculture and will replace the one year post graduate diploma." (p.12).

It was also recommended that after graduation in the BSc and MSc the Department would supervise and guide the graduates in the field to facilitate their registration by the Engineer's Registration Board (pp. 12-13), until there are enough engineers in the field to take over this task.

1990 Review Mission

Although the Department of Agricultural Engineering was converting from a BSc curriculum that took the A level students, to one that was taking O level students (the 8.4.5) system, this 1990 report did not comment on how the undergraduate programme was modified.

On the MSc programme, by 1990 only very few students, about 26, had graduated. The students had a choice of 36 different courses to choose from. Other than asking for more detailed description of courses and especially the manner of instruction, the mission stated that the programme compared with other curricula internationally. The issue of rural research, particularly availability of instrumentation, was highlighted. Since only a few students had gone through the programme it was not possible for the mission to make any systematic judgement about the content and to recommend changes. This review mission, from interviews of a few MSc students showed that they expected to work for government, in the private sector and self-employed as consultants (p. 11). Consequently, the mission emphasised that the programme seemed to call for generalists rather than specialists. However, it called for a systematic tracking system.

This mission also pointed out that there was no system of quality control on both the curriculum or individual courses. Quality control for the student who embarks on a thesis and drags the process was emphasised, for it reflects on selection and supervision.

This mission concurs with the conclusions of the 1990 Mission that the curriculum is comparable to other international curricula. It does not have further specific criticism about any particular courses offered, except the (for chapter 4) important observation that it is an engineering course with a slight orientation towards agriculture.

2.2 Research, theses and other publications

According to the Department's request for the fourth phase of Netherlands' support "The Department has taken a lead in Agricultural Engineering Research as evidenced by the large number of research publications, on-going staff research projects, available resources, qualified researchers and on-going post-graduate programmes." However, the Department did not furnish the review team with evidence to fully substantiate such

bold statements. Despite repeated requests, the Department was unable to produce a comprehensive list of staff publications during the period of the review.

Since the beginning of Netherlands's assistance, over 100 person-years of research (and teaching) activities have been carried out by staff of the Department. The research falls under three main categories:

- Research carried out by staff members for their own MSc and PhD Degrees.
- Subsequent research carried out by staff members within the Department.
- Supervised student projects at BSc and MSc levels.

In addition, some staff members have undertaken non-academic research in the context of consultancies, but these have not been implemented under the auspices of the Department.

Staff research for MSc and PhD has generally been undertaken away from Kenya (generally on topics of relevance to the host institution). The level appears to have been entirely satisfactory, in that most staff members have obtained their qualifications from world-class institutions. Even where the relevance of this research to the Kenyan smallholder sector has been limited or non-existent, the intellectual processes should (in theory at least) have equipped the staff to carry out relevant research projects back in Kenya. Staff appears to have produced one or two international publications relating to MSc and PhD research.

On the basis of interviews with staff and some limited lists of publications produced by Department members, it appears that few staff members were able to develop rigorous research programmes once they had completed their externally based research projects. Mitigating circumstances have been teaching loads (but staff-student ratios have been quite favourable) and low staff morale after the 1993 strike. There was no suggestion that planned research programmes have been constrained by inadequate funding or resources. Applied soil and water research has been carried on for several years, but while this has led to increasing understanding of the issues and constraints, it has not led to significant research publications. Only in recent years has there been any attempts at rigorous research relating to animal draft power.

The topics of MSc student research are listed below. Most have been in the field of soil and water engineering. Details of any national or international publications that might have arisen from these theses were not available from the Department.

The following Table 1 lists the MSc Students and thesis topics by year.

Table 1 *Topics for theses by MSc students*

1. Karanja, A.K. 1981. The Use of Infiltration Parameters in the Design of Long Furrow Irrigation in Lower Tana Basin.
2. Chuaga, F.N. 1981. Water Balance Study of Thiba Section of Mwea Irrigation Settlement.
- 3.* Butuk, N.K., 1983. Fluidized Bed Combustion and Gasification on Corn Cobs.
- 4.* Barrow, E.G.C., 1985. An Analysis of Human and Environmental Factors in the Agricultural Development of East Pokot (Nginyang Division, Baringo District, Kenya) - A Case Study Vol. I & II.
- 5.* Odeck, O.L. 1986. Evaluating Field Application Efficiency for Rice Irrigation Systems.
6. Busere, N.S. 1989. The Effect of Surface Stone Cover on Soil Loss and Runoff.
7. Bekele, M.W. 1989. The Influence of Surface Residue on Soil Loss and Runoff

8. Chepsoi, J.K.T. 1990. Hydraulic Performance of Small Basin Irrigation.
9. Kamau, B.C.L. 1990. Financial Evaluation of Private Smallholder Pumped Irrigation Projects in Kiambu District, Kenya.
10. Gachimbi, L.N. 1990. Land Degradation and its Control in the Kibwezi Area, Kenya.
11. Gicheru, P.T. 1990. The Effects of Tillage and Residue Mulching on Soil Moisture Conservation in Laikipia, Kenya.
12. Muturi, S.M. 1990. Technical Evaluation of Furrow Irrigation in Bura Irrigation Settlement.
13. Mwangi, J.N., 1990. Evaluating the Technical Performance of Kibirigwi Sprinkler Irrigation System.
14. Ndugo, K.K. 1990. The Performance of Animal Drawn Mouldboard Ploughs.
15. Nindo, C.I., 1990. Some Performance Aspects of Seed Maize Processing Operations.
16. Mburu, J.K. 1990. De-Watering and Drying Characteristics of Coffee Pulp.
17. Mwithaga, G., 1990. Change of Pyrethrin Content During Drying of Pyrethrum Flowers.
18. Kanali, C., 1990. Effect of Soil Compaction by Transportation Vehicles on the Sugarcane Fields of Mumias Sugar Company.
19. Njau, F.K., 1990. An Investigation of Safety Aspects in Selected Agricultural and Industrial Working Environments.
20. Owende, P.M., 1990. Development and Performance of a Toolframe for Mechanical Sugar Cane Stool Destruction.
21. Nyaguti, J.O. 1990. Drainage for Salinity Control in Kimorigo/Kamleza Irrigation Schemes.
22. M'Marete, C.K. 1991. The Bearing Capacity of the Soils of Ahero Irrigated Rice Field under the Exposure to Land.
23. Nyagah, C.N. 1991. Evaluation of Seepage Losses in Unlined Canals of Bura Irrigation Scheme.
24. Chiti, R.M. 1991. Effects of Farmyard Manure on Soil Surface Sealing and Crusting of Disturbed Top Soil - A Case Study of West Pokot, Kenya.
25. Gebre-Georgis, G.Z. 1991. A Comparison Between Conservation and Conventional Tillage Systems for Maize Production.
26. Moges, A. 1991. Water Conservation and Crop Production Under Two Agroforestry Systems: A Laikipia District Case Study.
27. Mukui, H.M. 1991. Evaluation of the Effect of Surface Soil Removal on the Growth of Wheat.
28. Mwaniki, J.M. 1991. A Comparison of Different Grasses as Filter Strips for Soil and Water Conservation on Crop Land.
29. Home, P.G., 1991. Drainage of Lowland Sugarcane Fields: Mumias, Kenya.
30. Nyaanga, D.M., 1991. Factors Affecting the Bulk Size of Potatoes During Storage.
31. Gikonyo, J.K. 1992. Influence of Drip Irrigation and Ground Water on Soil Water Balance of a Fluvisol in Kapsengare, Kenya.
32. Gathenya, J.M. 1992. Water Balance of Sections of Naro Moru River.
33. Mati, B.M. 1992. The Influence of Crop Cover on Soil Erosion by Splash.
34. Akal, A.B. 1992. An Investigation into the Causes and Dynamic of Slope Cutting in Timau area, North Western Foot Slopes of Mt. Kenya.
35. Fuchaka, P.W. 1993. Evaluation and Calibration of Field Techniques to Quantify Crop Cover.
36. Mwangi, T.H., 1993. Runoff Harvesting Potential for Crop Production in Kitui, Kenya.
37. Marenja, M.O., 1993. An Operational System Model for Raw Material Flow in the Sugarcane Mill Yard of Mumias Sugar Company.
38. Gitonga, M. 1993. Gulley Development and Control on a Volcanic Ash Soil at Okaria, Kenya.
39. Gikonyo, J.K. 1994. Sediment Yield Studies in the Mathare River Catchment.

40. Onyando, J.O., 1994. Estimation of Runoff Volumes and Peak Rates from Rural Catchments in Kenya.
41. Shitanda, D., 1994. Physical Properties of Crusade Oil from Indigenous Oilseeds in Kenya Compared to those of Petroleum and Conventional vegetable Oils.

*NB * MSc theses studies studied and submitted in Universities abroad.*

As far as other publications are concerned, the team cannot present a proper insight in the publications the Department produced. From the first day of the mission, the Department was requested to provide the team with this information. Only on the last day of the 'field work' a list was given for the publications made by Dr. Kaumbutho and one for Dr. Mwaura. These two lists are in Annex IV.

2.3 Animal draft power programme

An Animal Draft Power Programme has been operating within the Department of Agricultural Engineering since the early 1980's. Over a period of 14 years, it has consumed considerable staff time and resources. In the third phase about one third of the Dutch co-ordinator's time was devoted to this programme. Even in recent years, with only about 20 % time allocation of the expatriate coordinator, activities and salaries related to animal draft still accounted for about 10 % of the total forth phase budget.

In the early 1980s, two members of staff (the then Chairman Mr G. Muchiri, and a visiting Lecturer from the Netherlands, Mr Dibbits) wrote about the importance of animal power in the smallholder sector of Kenya. As a result, an Animal Draft Power component was included in the Integrated Smallholder Agricultural Engineering Research Proposal of 1981 (Fowler and Kinyanjui in 1982).

During the period 1981-85, Mr Dibbits played a very active role in developing animal draft power initiatives at Kabete. Oxen and donkeys were trained and a variety of prototype carts, implements and harnessing systems were assessed. Particular attention was placed on modifying prototype collar harnessing systems. With the assistance of Mr Micuta of the Bellerive Foundation in Switzerland, modified collar harnesses were developed, and found to be suitable in on-station trials.

The persons involved in the launch of the Animal Draft Power Programme appear to have had a flair for publicity and stimulated much interest in their work. The new (prototype) harnesses were demonstrated during agricultural shows and papers and articles describing the benefits of the harnesses appeared in several Kenyan and international publications. As a result, the Department of Engineering of the University of Nairobi acquired a national and international reputation relating to animal draft power which lasts to this day. Since there was no local supply of such harnesses, a fabrication facility was established within the Department and people from several parts of the country were also trained to make them. As word spread of the success of the so-called "UniDib" collars (University of Nairobi - Dibbits), technicians from Zimbabwe and Zambia were sent to the Department of Agricultural Engineering to be trained how to make the collars.

Following the departure of Mr Dibbits in 1985, members of staff of the Department continued to promote the collar harnessing systems through demonstrations at agricultural shows and through collaboration with interested organisations. The technology was retained without significant changes. The long-term Dutch Lecturer, Mr Oudman, assisted by some technicians and harness makes developed an extension programme, the Animal Draft Power Project that operated mainly in Western Kenya. This project received some inputs from the Dutch support to the Department and additional funds from a Netherlands foundation and the Blue Eagles foundation. The

project, which is on-going, worked with co-operating NGOs and church groups. In Homa Bay District, six special demonstration farms were established (District Demonstration and Contracting Units or DDCUs) and more are planned. Along with promoting harnessing technology, the DDCUs promote an "improved" ox yoke, weeding technology and Rumpstad equipment. Animal health care, notably spraying for tick control, was also promoted.

Most publications relating to the harnessing and other animal draft power issues have been based mainly on undisguised enthusiasm and anecdotal observations. There appear to have been no attempts by staff or students to undertake objective, replicated research relating to harnessing systems. Nor does it appear that any rigorous literature reviews were carried out. A prototype system for carrying slurry in donkey panniers was developed as a student project.

In 1990, two MSc students undertook studies relating to animal power implements. One related to a prototype sugar-cane stool remover, and the other a study of plow performance.

In 1992, KENDAT (Kenya Network on Draft Animal Technology) was launched as an NGO aiming to develop animal power in the country. Since its formation, its Secretariat has been located within the Department, benefiting from Dutch-funded equipment. Its Chairman is a member of the Department (Dr P. Kaumbutho). In 1992 it held a national workshop supported by Netherlands' funds. In 1995 it held a second national workshop (supported by the British Overseas Development Administration) and hosted a large international workshop under the auspices of the Animal Traction Network for Eastern and Southern Africa (ATNESA).

Since 1992 there have been some attempts by staff members to undertake some objective research relating to animal power. Mr Owende is carrying out a PhD programme on the dynamics of animal drawn plows. Dr Kaumbutho, in collaboration with Dr Gebresnebet of Sweden, has been starting to obtain and or develop instrumentation that could be used to measure the performance of animals and implements.

2.4 Networking

Members of the Department have contributed to, and benefited from, several national and international networks. These have included the Kenya Society of Agricultural Engineers (KSAE), the Society of Agricultural Engineers in Southern and Eastern Africa (SAESEA), the Network for Agricultural Mechanisation in Africa (NAMA), Programme on Agricultural Operations Technology for Small Holders in East and Southern Africa (AGROTEC), the Kenya Network on Draft Animal Technology (KENDAT) and the Animal Traction Network for Eastern and Southern Africa (ATNESA). Several staff members have been office bearers or key people within these organisations that all aim to improve linkages between people and organisations and to enhance professional standards and capacities.

2.5 Staff & students

The achievements in relation to staff development can best be summarised in the following Table 2.

Table 2 *Staff trained*

1.	Mungai	Short course ICRISAT
2.	Mwaura	MSc Dublin State + PhD

3.	Chuaga	MSc locally / no longer employed
4.	Muchiri	PhD study in India/Wageningen
5.	Some	MSc UK PhD
6.	Gumbe	MSc UK PhD Ohio State University
7.	Gichuki	BSc-PhD Utch. State University
8.	Mungai	Siboe 1980 BSc MSc PhD Michingan State
9.	Serem (1990)	MSc Canada, PhD S McGill
10.	Maende	UK, PhD
11.	Owende	Dublin, PhD
12.	Kambutho	PhD Michigan State University
13.	Muni	PhD study Colorado State University
14.	Muturi	PhD study, UK
15.	Butek	PhD USA (no longer employed)

Not through Netherlands support

16	Biamah	busy on PhD in Wageningen
17.	Inima	?
18	Marenja	MSc in Kenya

About half the staff members had completed their studies by the beginning of the 1990s. It was by then that a critical mass had been established.

The following Table 3 specifies the students that have been trained. Comparing this output with the figures obtained for JKUAT and Egerton (resp. 40 and 100 BSc), it can be observed that this Department is the smallest of the three. Female representation in the BSc course with less than 3 % is insignificant. In the MSc course this is about double.

2.7 Infrastructure & equipment, etc.

The Netherlands Government support expanded the Department's teaching and research facilities. It specially funded the following:

- Three floor Agricultural Engineering building with classrooms, staff offices, Documentation Centre and computer room.
- Three laboratory wings to accommodate the soil and water laboratory, processing laboratory, wood workshop, metal workshop, tools and equipment store, farm power workshop, material store, farm machinery workshop and shed, and the draft animal power workshop.
- A wide range of teaching and research equipment for the above workshops.
- motor vehicles and tractors.

Table 3 *Students trained at the Department of Agricultural Engineering UON*

Year	Undergraduate BSc		Graduate Diploma		MSc
	male	female	male	female	
1978/1979	6				
1979/1980	11		11		
1980/1981	16		2		
1981/1983	29	1	3	1	
1983/1984	16				
1984/1985	5		5	1	
1985/1986	14				

1986/1987	22				Intake - 8
1987/1988	21	2			
1988/1989	20				Intake - 10 Fail- 1
1989/1990	35				Intake - 14 Fail-1
1990/1991	25	1			Intake - 5 Fail- 1
1991/1992	24	1			Intake - 25 Fail- 5
1992/1993	27	2			Intake- 8 Fail- 1
TOTAL	280	7	21	2	Intake - 78 out of which 5 female Fail- 9

This information is given as a matter of fact. Within the context of this review there is no time to assess the needs for infrastructure, equipment, etc., and by consequence, no comments are given except in § 7.3 on available equipment in relation to the sharing of equipment with the Faculty of Engineering.

At this point the conclusion could be that project has achieved its short-term objectives quite reasonably. Through the production of 375 graduates it can be expected that also the long-term objective has been / will be met.

The review could have gone deeper into the details of all these achievements. Collect more quantitative and qualitative data to substantiate this satisfactory conclusion.

However, the review team decided that the proper evaluation of this project, and especially its long-term objective, can only be achieved if it is placed in the wider context of the changes in thinking about agricultural research, extension and technology development over the past two decades.

This context is given in the next chapter 3, after which the achievements are assessed in chapter 4.

COMMENTS ON THE DRAFT REPORT

The final draft report was presented to the donor in early January 1996. By the end of February 1996, a letter by the Chairman of the Department, comments by the Academic Staff, and a reaction by the donor had been provided to the Team.

These comments on the draft report received from the Department of Agricultural Engineering and the reaction of the Royal Netherlands Embassy to those comments have been studied carefully.

A paramount conclusion of the Team was that the Department missed the main developments in thinking about agricultural production in East and Southern Africa. The overall understanding of the Team is that the comments and statements of the Department demonstrate the 'engineer' point of view and underline such a conclusion of the Team.

Interestingly, the Department apparently accepts the subsequent recommendation of the Team that the curriculum needs considerable change (brainstorming by the Department about this indeed has started recently) and even requests the donor for 20 years, to financially assist the Department with this. The department further states that a Farming Systems approach is not (yet ?) official policy at the level of the ministry, and that the T&V system as promoted by the World Bank is officially still in force. This is correct to a certain degree, but negates the fact that important changes are being made and have been achieved over the past years - also in relation to the extension system. An important example in this (KARI's approach in the implementation of NARP II), is given by the Department in its reaction.

The Department rightly observes that the Draft Animal Power Project got considerable attention in the report. The donor deliberately included an expert in this field in the Team and, as a consequence, ample attention is to be expected. The Team considers such attention as justified. First, the DAP project has always featured as one of the success stories of the Department. Second, the Team was to have an advisory role on making the programme offered by the Department more sustainable. The Department has frequently indicated that especially activities originating from the DAP might in the future generate income for the Department. This warrants an in-depth assessment of the DAP by the Team.

Considering the above, the Team sees little reason to make changes in the report but honours the request made by the Department and includes in the final report (as Annex V) the comments given by the Department's Academic Staff.

3 THE CHANGING ENVIRONMENT FOR AGRICULTURAL RESEARCH, EXTENSION, TECHNOLOGY DEVELOPMENT

This chapter reviews developments in (i) agricultural research, (ii) extension and (iii) education in Eastern Africa over the past two decades. Although discussed separately for matters of clarity, it must be understood that these three processes are intimately interlinked. The project, to be effective and efficient, should be in line with recent developments in agricultural research, education and extension thinking. It should therefore have addressed smallholder production - 80% of Kenya's agricultural production.

3.1 National agricultural research programmes

In the East African region, important developments in national agricultural research took place during the past decade. Predominantly instigated and co-ordinated by the WB and assisted by ISNAR, the reorganisation of agricultural research dramatically changed the research scene.

Since their start, the implementation of the national agricultural research programmes such as the National Agricultural Research Organisation (NARO) in Uganda, the National Agricultural and Livestock Research Plan (NALRP) in Tanzania and the National Agricultural Research Programme (NARP) in Kenya, suffered from a variety of fundamental constraints. All agree that problems encountered in smallholder production are complex. Solutions or recommendations should, therefore, deal with a variety of spheres, often at different levels of scale and analysis. Research in the different components of the national programmes, thus, must be multi-disciplinary. Creating such teams is itself complicated. First, most scientists usually tend to consider their own discipline as primary. Second, agricultural scientists argue that their discipline is already interdisciplinary and thus little need exists for adding other specialists to teams. Third, there usually is a presumed difference in discipline status. Some observers tend to conclude that the more expensive the hardware needed by a discipline, the higher the discipline status. In agricultural research, status ranking has genetic research and biotechnology as well as high yielding variety research on top. These are followed by agricultural economics and farming systems research in the middle. At the very bottom are farmers' knowledge and the relation between scientist and farmer, let alone on-farm research in which the farmer is involved.

Western agricultural production methods produced farmers specialised in crop monocultures or livestock. Western agriculture education taught that with the application of technology, natural constraints could be conquered. In this Western vision, nature was not an obstacle to economic development. Inadequate technology and cultural traditionalism were. Such an approach was basically successful where good soils were available and massive inputs into agricultural production could prevent major environmental and harvest degradation. This tradition led to specialisation and de-linking of agricultural services such as research, education and extension. It was exported through training.

Senior scientific and extension staff in the Eastern African countries has generally trained along strictly disciplinary and in-depth scientific techniques. Training is usually abroad and out of local context. Frequently, it is not at institutions that are involved in thinking about discipline integration or that had experience with smallholder production systems.

In the East African production circumstances, nature's determinism is difficult to ignore and farmers tend to attach predominant value to reduction of risks, instead of

maximisation of yields. The soils are generally poor and fragile, the climate is erratic and access to resources is usually limited. Agricultural research and related activities are now formally there to serve small holder peasant farmers who have to produce in circumstances that are entirely different from those in Europe, America or Asia. This farmer needs assistance in improving his complex farming system in total. Education in technology development has not yet come to aid the farmer.

The East African smallholder farmer cannot easily rely on a mono-culture. (S)he needs intercropping systems, alley cropping with productive trees and livestock to support the family. (S)he also needs cash crops as well as subsistence crops. All these should be integrated into a farming system that optimises the use potentials of the economic and natural resources without destroying the latter. (S)he needs facilitative appropriate technology to sustain production. Often such a perspective is lacking within the different agricultural services and donor supported projects.

The very fact that small farmers in the region did not perform according to the expected Green Revolution (see § 3.2), forced researchers to try to understand the way the small farmers behave and manage their farms. Research had to understand relations between different production factors and the difference between producing for market or for subsistence. Farming Systems Research was introduced, first as an analytical tool in the seventies and later on, in the second half of the eighties, with a much more important place for the knowledge and the participation of the farmers. This has triggered important changes in the set-up and approach of agricultural research in the region.

It has become clear the essential pivot in smallholder oriented research or extension activity should be the Farming Systems Approach (FSA). It started by developing Farming Systems Research (FSR) as one of the many programmes in parallel with other factor/commodity programmes (CIMMYT was ahead in using such systems approaches, but was still commodity oriented).

Lately, under pressure from the WB (!) and bilateral donors, FSR was transformed into a basic concept in all agricultural research and development.

Reorganisation of staff training is being considered in national agricultural research programmes. No longer should training be haphazard at assorted specialised institutions abroad, but according to well-organised and clearly focused national schemes where applied and interdisciplinary agricultural research is stressed. Such training emphasises modular on-the-job training based and alternates practical exercises and theoretical parts, with feedback from one module to the other. Some programmes stress the production of BSc staff arguing they are adaptable and, hopefully, still farmer oriented.

The Netherlands has reconsidered its technical assistance (-TA-) to national agricultural research in Kenya. Under NARP Phase I, TA was technology specific. In Phase II, the leading back-up is given by the FS oriented Royal Tropical Institute (KIT). Technical (subject matter specific) assistance will be subordinate to this FS approach. Similarly, in Tanzania, the Netherlands Government is supporting the establishment of FS teams all over the country to become the basis for smallholder agricultural development.

3.2 Extension; T&V system versus Participatory Technology Development (PTD)

The Green Revolution stressed high yielding varieties, high inputs, and mechanisation. Smallholder subsistence production was a temporary 'problem' that would be overcome soon. Relatively, it succeeded in parts of Asia. It has failed totally in sub-Saharan Africa where agricultural production per capita is falling. The majority of sub-Saharan farmers use very little external inputs like mineral fertilisers. The bulk

produces exclusively with locally available mineral and organic nutrients. This majority of small farmers did not accept the recommendations the commodity and factor oriented research stations developed, nor the equipment, implements and structures promoted by agricultural engineers, who worked on the basis of the same premise of intensification and mechanisation. These small farmers produce more than 80 % of the cereal production of sub-Saharan Africa.

Quite a number of aspects of agricultural development thinking are going through a phase of change. This can be summarised in a schematic overview as Table 4. It presents the different perspectives related to high or low input that agronomists can choose from when analysing rural and or agricultural development. The choice of a perspective has crucial consequences. Not only for research, for extension approaches, for relations with farmers, but also for choices of technologies to be further developed. Specifically, the technical aspects of low external input technology and production in low potential areas still require substantial attention.

Table 4 *Differences in looking at agricultural development*

Perspectives of looking at LEI(S)A agriculture		Green Revolution approach
Current share in cereal production in sub-Saharan Africa:	about 80 % in practice	about 20 %
Farming systems seen as:	comparatively diverse	rather uniform
Farm scale:	small-medium	medium-large
Environmentally seen as having:	comparatively high diversity	low diversity
Technology development:	'marriage' of indigenous and outside	brought in from the outside and adapted
Technologies offered:	Choices for the farmer to select from	Specific researcher-determined recommendations
R&D approach:	on-farm and on-station; baskets of choice	on-station; evt. on-farm demonstration; packages of practices
Scientific approach:	integrated and holistic; farming systems	reductionist; operational approach
Extension approach:	technology development joint effort of research, extension and farmers	transfer of technology
Extension system:	PTD	T&V
Planning:	bottom-up	top-down
Policy goals:	enable sustainable agriculture and conserve natural resources; maximise small holder diversification	maximise (output of) specialised production of commodities
Output:	food crops/cash crops	cash crops

The main extension system, in Africa, is the Training & Visit (T&V) system, being the climax of commodity related extension. It follows the targets of economic and land use planners and it builds its strength on concentration by its extensionists on one or two main crops. In theory, the same farmer is visited by various extensionists, all with disciplinary messages without complementarity or synergy. These numbers of extension staff draw heavily on national financial resources. Their budgets are shrinking.

Growing understanding of the complexity of smallholder farming systems and the recognised need to use local resources, have created new links between key actors. This was incubated within NGOs outside the 'mainstream'. Some extensionists worked in close relation with small farmers, and some individual researchers. Much more reliance on farmers' knowledge was essential to this development and joint on-farm trials on alternative ways of growing crops, keeping animals and using technology came into existence. A more participatory way of technology development emerged in which applied research and extension are strongly interlinked, if not integrated. This new approach to extension and research is 'Participatory Technology Development' (PTD). This approach is in strong contrast to the traditional way of agricultural engineers (see § 3.3).

It is defined as activities aimed at, or resulting in a *change of the existing technology* in a direction that is considered desirable by the different users of that technology (mainly farmers) and which are carried out *by networks in which the users of the technology play an active role*. In practice, a logical framework of activities is to be carried out in PTD. These can be presented in a schematic form:

Get started

- Build up relations of confidence and lay a basis for co-operation in analysis.
- Analyse existing environmental situation, farming systems, problems, networks (PRA or RRA, etc.).
- Establish relationships with existing networks or form networks for PTD.

Finding things to try (also part of PRA's)

- Take stock of indigenous technical knowledge and formal knowledge.
- Screen possible experiments related to varieties, soil/water systems, indigenous processes, tools, techniques and structures.
- Select experiments.

Trying out

- Assess and develop experimenting capacity.
- Choose subject.
- Ensure farmers have a choice of technology options.
- Design dynamic operational plan for experiments.
- Manage the experiment (could be on-farm as well as partly on-station).
- Assess the results.
- Analyse and understand the experimental process.

Sharing results

- Carry out extension (farmer-to-farmer and otherwise).
- Carry out training in use of new technology and in methods of PTD.
- Produce communications and training materials.
- Ensure relevant producers and services.
- Ensure input supply.

Sustaining the process

- Create favourable conditions for peasant organisation, local institutions, policy-level support, physical infrastructure.
- Repeat the process.
- Analyse and document the process.

The above description is very brief but it indicates main lines of recent developments. FSR as well as participatory approaches are coming into the 'mainstream' of development of small scale agriculture in Eastern Africa. It is against this background of developments in small farmers' agriculture that the mission analysed the performance and the relevance of the project.

3.3 Training at Universities for Agricultural Engineering

In the field of agricultural engineering, much "research" in the region in the 1960s and the 1970s involved the development of prototype equipment at Universities and on research stations. Conceptualisation, fabrication and testing were generally carried out by the engineers alone and once it was judged satisfactory, the extension Department was encouraged to promote the new prototypes. Throughout the region, engineers designed their own seeders, oil presses, toolbars, "improved" stoves, grain stores, biogas digestors and maize hullers. Almost all failed to be adopted. The engineers generally blamed poor extension and reluctance of companies to market their products. A classic example was the animal-drawn wheeled toolcarriers. At least eight different original designs were invented in Eastern and Southern Africa alone, and on-station trials were carried out in all the countries in the region. However, these implements that have been "perfected" by the engineers on research stations were conclusively rejected by the farmers. These implements that had been considered appropriate and profitable from the on-station work were found to be technically and economically in-appropriate in the reality of the smallholders' farms.

The perception that important changes are to be made has not yet reached the third side of the triangle, the training institutions, in a similar degree as it has the national research and extension systems. One of the crucial constraints in changing these research and extension systems is the attitude of staff involved, which is a direct result of how and where they have been trained.

As far as the review team knows, there exists only one focused effort in East Africa to change this top-down and on-station attitude in the field of agricultural engineering. It is the AGROTEC programme "Agricultural Operations Technology for Small-Holders in Eastern and Southern Africa" covered Kenya, Lesotho, Tanzania, Uganda, Zambia and Zimbabwe. AGROTEC is financed by SIDA and was executed by UNDP/OPS (now by FAO) which subcontracted the International Rural Development Centre (IRDC) of the Swedish University for Agricultural Sciences for the recruitment of professional staff to the regional office or AGROTEC secretariat.

The ultimate goal or development objective of the programme is described as "increased food production in the AGROTEC region through improved productivity and production in the small scale farming sector". According to the programme, this can only be achieved through improved farming systems and/or better farm operations technology. A change in the attitude and approach of agricultural engineers was recognised as a main overall objective

Although the objectives and the perception of the project are correct, an evaluation in 1994 concluded that the project's impact was insignificant predominantly due to managerial and organisational flaws. The Department of Agricultural Engineering of the University of Nairobi participated in the AGROTEC project.

4 ACHIEVEMENTS IN THE WIDER CONTEXT OF CHANGES OVER TWO DECADES

4.1 The dilemma

From the previous chapter 3 it became clear that considerable changes took place in the thinking about agricultural production. The top-down, high tech and high input ('Green Revolution') approach has gradually been replaced by participatory options. Since the concept of the Department is basically similar to the one in 1976, gradually the dilemma emerged: either to cherish academic freedom and pursue academic standards and interests exclusively (which was compatible with the 'Green Revolution' thinking), or to become oriented on the real needs of agricultural production.

The Department apparently made the implicit choice to continue as started. This was reinforced by the freedom of choice for the PhD study. All staff did their studies abroad with a heavy concentration on mid-western American Universities. These Universities as Ohio and Michigan State Universities were purposely established to satisfy the needs of large scale mechanised farming in the USA.

Considering the long-term objective the donor adheres to the project, and considering that smallholder production represents not a thing of the past but the mainstay of present and future agricultural production, the team thinks that the donor would opt for a development and smallholder oriented approach at the Department. In that respect it is remarkable that the donor or the expatriate staff continued in accepting the total freedom of choice for PhD training abroad (in the USA) and choice for MSc theses. As stated in § 1.3, it is laudable that the 'ownership' was left with the Department, however, when this leads to developments that will make the long-term objective nil and void, at least a serious discussion between Department and donor should have resulted (see also § 7.3.4).

Despite review missions and expatriate input, the project lacked a 'learning mechanism' and remained shielded in the comfort of its ivory tower while the outside world was changing rapidly and substantially. The team thinks that the Department is hardly to blame for this. The critical mass at the Department was not established until the 1990s and the learning mechanism should, in the meantime, have been provided by the external input (it is not the individual expats who are largely to blame, since they were selected and mandated for a restricted role; essentially as additional teaching staff while future staff was abroad for training. In § 7.3.4 it will be described how the donor lost track of the long-term objective a long time ago.

At the time when that critical mass existed and the first attempts were made by the staff to start strategic thinking, the donor decided to phase out. This was poor timing and damaging to morale.

4.2 Curriculum and human resources

It appears it has become the tradition of the agricultural engineering Department to get more theoretical and ignore socio-economic courses. A review of 1987 B. Sc. curriculum with 42 possible courses and the 1991 B. Sc. curriculum with 79 possible courses supports this contention. At the same time there has been less and less time for practical work. This practical work would have been essential for at least (some) farmer orientation.

The 1991 BSc curriculum had only 10% of the courses outside what are in essence engineering courses. This is a reduction of 4% from the previous BSc curriculum! The courses that constitute the 10% are: 1. Fundamentals of Development and their Application to Kenya 2. Element of Philosophy 3. Communication Skills 4. Statistics and Experimentation 5. Operational (sic) Research 6. Principals of Animal Production

7. Farm Management and Agricultural Extension and 8. Engineer in Society. It is worth noting that the economics course was dropped! Further, it should be noted that the Department did not avail the mission with course descriptions and thus it is not possible to comment on what the strange mixture of courses covered. It is though doubtful that many matters of import to smallholders and their production were covered in these courses.

The MSc curriculum has 91 possible courses. Only 3% are non-engineering! These are Project Planning, Statistics and Experimentation and Social and Physical Ecology. Perusal of their descriptions confirms strongly that matters related to smallholders and their production systems are not systematically covered.

4.2.1 Relevance

In terms of how the programme is related to the long-term objective of improving smallholder agriculture, we believe this could only have been achieved by building into the undergraduate and graduate programmes active involvement of the students and staff with smallholder farmers. In other words, by structuring more field activity. The omissions were made by the three parties involved in the project: the Department, the Donor and the review missions.

Opportunities were lost in terms of discussing how the BSc and MSc programmes related to the long-term need for the project to address issues of smallholders. Although the 1985 mission called for more practical orientation in the BSc programme, there was no detailed discussion on the curriculum especially in relation to the introduction of the 8.4.5. system after 1989. There has been an increase in the number of theory courses. Staff members agree on this point. Issues of how much practical training, which would be farmer oriented, could be put into the BSc curriculum were not addressed by the Department. It assumed that the BSc would be a good platform for the MSc. Therefore, there was no exploration of how farmer oriented training could be structured at the BSc level to feed into the MSc level through those who graduated into it. There was no attempt to state the demand for agricultural engineering in this sector then or later. The 1985 review exclusively focused on justifying the MSc programme.

The 1990 Mission was interested in streamlining the MSc programme although its terms of reference specifically called for judgement on how the project showed:

- “concurrence with latest knowledge/ideas”, and
- “to which extent are students apart from necessary technical subjects exposed to such non-technical subjects as farmer involvement and attention to socio-economic issues prior to project implementation?” and
- “to which extent is the education programme in agreement with the actual work the students are expected to do after finalisation of the study?”.

It seems to this mission that all parties have brushed aside the issue of farmer oriented practicals by focusing on how the Department can supervise the students after they leave the campus to facilitate their certification. If the option of increasing much more practical training was taken for both levels early, then it could offer a way out to the certification problem. The mission does not see how the Department can become the supervisor of products employed by others to enable them to be certified.

It is a summary point then that the donor did not pursue the issue of long-term contribution to the smallholder sector for it would have raised it with the Department, the project coordinator or even the past missions.

4.2.2 Level of training

Evidence presented to the mission suggests that the project has contributed to overtraining and thus militated against the interests of smallholder farmers. The first issue is how the project dropped the Post Graduate Diploma course and went into MSc training.

A first note is that two Dutch funded projects seem to have been responsible for pushing for higher level training. The Smallholder Irrigation Development Project, in the Ministry of Agriculture by 1977 had 12 Dutch TA, many of who were in line positions. Those running this project and those at the university, in keeping with Dutch ideology, saw the need to *produce personnel to service other Dutch projects*. The 1982 Mission, the first external one, stated that "The funding of the Department was consistent with need to train professional manpower as counterparts for other Netherlands funded projects in Kenya." This fact was clearly articulated in 1980 when there was a proposal to discontinue funding the project. From the project document it would appear that Netherlands experts in the Faculty played a major role in its formulation. The reference here is to the Netherlands TA that was in crop science and which also spawned the Department of Agricultural Engineering.

It should be noted that Dutch TA to the SIDP had grown to 25 in line operations in the MoA by 1983. Thus, when the 1982 Mission argued for replacement with local highly trained personnel, it hit a chord. Many Kenyans saw jobs in replacing Dutch TA. It fed on the initially BSc level staff training to come to the line operations of the ministry and later the post graduate diploma. This fitted the interests of the Kenyan MoA officials who were looking for advancement through training first, and then replacement of the Dutch. The two sides generated the pressure which by 1983, when there were 25 Dutch TAs in the MoA, began to build for training at the higher level to reduce the TA as well as generating university lecturers.

This objective was achieved by 1985, essentially through the post graduate diploma. By 1985, Dutch TA had been reduced to 12 and by 1994 to 2. The SIDP concluded in June 1995 without a terminal evaluation.

The MoA is desirous of such an evaluation for it would assist it in evaluating overtraining.

Perusal of the 1985 Mission report also shows that Dutch TA in the SIDP, Dutch TA at the University, Kenya University staff and MoA staff trained under the project were arguing in support of the MSc, without establishing a national demand for it. Staff at the MoA, who were junior staff then, argue that the MoA in general did not support the establishment of the MSc programme. It should be noted that these senior managers now came into the project through the post graduate diploma. Their previous work had been in extension in the MoA and they are thus partisan to the field extension approach.

The second issue is the current problematique of staffing at the MoA Land Management Division especially. This Division was essentially created out of the Dutch funded SIDP. Senior managers there argue that idealised 1995 demand for Agricultural engineers is 317 staff. Current staffing is 142 (see the following Table 5).

It is worth noting that the 1982 Mission established that the percentage of BSc graduates who were in the MoA was just over fifty. If parastatals are added to this, 64% of all graduates were in public service. This compares to the 142 currently employed by the MoA out of 375 trained both at the B. Sc., Post Graduate Diploma and MSc. In other words, 38% of all those trained are in the MoA. On the other hand if one counts only the BSc graduates the 142 figure is just about 50% of the total 287 produced to date.

It, however, should be noted that over the past four years, the MoA has only been authorised to recruit a token number of the graduates. During 1995, it was only authorised to recruit not more than 10 out of the projected output of about 120 from Nairobi, Egerton and JKUAT. Thus, only about 8 % of this year's graduates have a chance for public sector employment.

Table 5 *Employment opportunities at the MoA*

<u>Idealised demand by the MoA</u>	
Irrigation	120
Soil and Water	70
Mechanisation	31
Rural Technology Centres	
Agricultural Extension	61
Coffee Factories	27

Total	317
 <u>Staff in place at the MoA</u>	
Soil conservation	20
Irrigation	68
Mechanisation	30
Rural Structures	24

Total	142

These statistics are only presented to firm up an argument that there is perhaps an oversupply of university trained agricultural engineers from Nairobi. At the same time there is a shortage of agricultural engineers at the Diploma and Certificate level.

The shortage at diploma level is related to the first project decision to train at university level. Egerton followed with pretty much the same curriculum. Significantly, it stopped the diploma course to give the BSc similar to Nairobi. Jomo Kenyatta UAT first graduates hit the market this year. The shortage in MoA at the Technical Officer level has become so serious that three years ago, GoK made the decision to start training at that level at Bukura. Since the MoA cannot recruit new staff, it is forced to recruit such trainees from the certificate holders in payroll. *This practically means that the technical extensionists are being depleted.* Smallholder farmers are losers in this operation.

Limited interviews in the private sector and the NGO sector also suggest that there has been overtraining. In an interview with a BSc working for Unilever, he argues that together with his other two colleagues in the company, the training is essentially general education for they are salesmen. Of course it is useful. Their classmates are an academic, a draftsman in an engineering firm and a small business consultant in non-engineering activities.

One NGO, which employed a BSc graduate, argued that they employed him because he did some extension with the MoA after doing the BSc. They bought the extension, not the engineering.

4.2.3 Planning

In Politics, Economics and Technical Training, a study of technical training in Kenya, (Nairobi: Kenya Literature Bureau. 1979, E. M. Godfrey and G-C. M. Mutiso) it was concluded that "...the private rate of return to academic education beyond certain levels

has fallen, in relation to the private rate of return to technical training, to such an extent that technical training has for the first time become an attractive proposition." (p.21). This conclusion captured the tenor of the times when technology was supposed to save the country. Agricultural engineering was part of that saving bundle of technologies. Has it now gone the route non-technical education?

Data from interviews and previous missions suggest that the initial training in BSc and the Post Graduate Diploma course was extremely useful. It generated staff to replace Dutch TA. It generated a platform for selecting for staff training. It was extremely useful to some in the private sector as background to other activities. All these may be indirectly of importance to smallholders but it will be hard to systematically show how they relate to improving smallholder production. The fact that many go unemployed now is evidence of non-relevance of the training.

The team was informed by the MoA/Department of Land Management that GoK/MoA had to reintroduce diploma training at Bukura. This is prima facies evidence that demand for this level trained personnel is there. It raises the question why to create a top heavy pyramid. In the study cited above, it was concluded that the most serious shortage of technical personnel at the national level was at the diploma, the middle level. Other general personnel studies have made the same conclusion. Bukura diploma training recruits at the employed certificate level staff. This depletes extension staff who is in contact with farmers. It means that bureaucratic activities will continue to be done without effective extension. Since the country has very limited non-public sector extension, it is doubtful whether other agricultural engineering staff will have contacts with smallholders.

The hard conclusion is that if the project obeyed the spirit and letter of its long-term goal, it should have supported more extension activities and perhaps training at the diploma level. The forces who cohered to argue for the MSc degree in 1985, without doing a national personnel demand, have contributed to the negation of the long-term objective. Now even the few extensionists are being drawn into administrative bureaucratic levels.

4.3 Research, theses and other publications

The Department has long been aware that it has not had a clear research strategy. It has made attempts to formulate a research programme, most notably at the 1991 Masinga workshop. This led to a long list of possible research topics, many of which were vague and most of which have not been touched on. A Research Committee has been formed, but the Department is aware that it has not been operating effectively.

What has been written in § 4.1, is highly applicable to the research. Research is selected on basis of individual / academic preferences without any overall departmental strategy let alone taking into account the position and constraints of smallholder farmers.

The latter statement can be analysed from the theses' titles (see Table 1). Out of the 41 theses' topics, only seven could bear direct (## 9, 10, 11, 14, 24, 25 and 28) and two (## 7, and 30) possible relevance to the smallholder production sector. The far majority of 35 titles bear no smallholder relevance.

It is normally very difficult for people to change their thinking without some outside support. Such support or guidance was apparently not given.

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4.4 Draft Animal Power programme

For over 10 years, the Department has been actively promoting the "UniDib" collars for oxen and donkeys.

The ox collar does not appear to have been adopted by farmers anywhere in Kenya. It has also been rejected by farmers and projects in Zambia and Zimbabwe.

People employed by the Draft Animal Power Project to promote the ox collar on the demonstration farms in Western Kenya had only been told of its advantages and they were not aware of its complete lack of adoption during the last decade of promotion (although they were well aware that farmers in their own areas were not using it). What is more important, none of the extensionists interviewed was aware that there existed simpler alternatives to the single ox collar, such as the single withers yoke.

Despite the lack of adoption, there appear to have been no attempts by staff of the Department to record and analyse experiences relating to these harnesses. Thus, the only publications on record are the initial optimistic ones. Staffs of the Department have not objectively investigated and recorded the comparative advantages and disadvantages of the various harnessing systems. The promotion of these ox collars is still on-going in 1995-96, despite inevitable erosion of the credibility of those promoting them.

The situation with the donkey harnesses is similar in many ways, although there has been some patchy adoption of these by farmers. In most cases, where there has been some adoption, it has been as a result of an NGO providing the harnesses either free-of-charge, or as part of a package. This is true of similar, low level adoption in other countries in the region. In most cases where farmers have adopted the donkey collars, they were not offered the alternative of a breast band harness. Breastband harnesses have been widely adopted by farmers throughout Africa, but they are little known in Kenya. Those responsible for demonstrating the collar harness on the Animal Draft Power demonstration farms did not know about breastband harnesses and did not have samples to demonstrate this (widely accepted) alternative to the innovative design being promoted. Only in the last year, has KENDAT stated to include breastband harnesses in its options for farmers, following collaboration with KSPCA in Limuru.

The methodology used for promotion of harnesses (and other technologies) has been based on the top-down extension approaches that generally failed in the 1960s and 1970s. In Homa Bay District, in particular, the establishment of demonstration farms to promote technologies selected by researchers, is highly reminiscent of the failed rural technology centres found in most countries in the region (including Kenya and Tanzania). It has been clearly established that such demonstration farms allow extensionists demonstrate inappropriate technologies year after year, with little chance for learning or constructive feedback. They also tend to be gender-biased and ignore crucial socio-economic aspects of the local farming systems.

All recent successes in animal draft power technologies in the region have come from on-farm evaluation by farmers themselves using technologies selected by the farmers from a range of options offered by the researchers. Examples of such participatory technology assessment and or extension have been seen in Zambia (Palabana), Tanzania (Mbeya and Tanga) and to a certain extent in Kenya (DAREP, Embu). Reports of these have been available internationally in the past few years, notably through the Animal Traction Network for Eastern and Southern Africa (ATNESA).

Besides harnesses, the Department and the Animal Draft Power Project have worked with a few other technologies besides including carts and most recently the Rumpstaid toolbar. Although there have been some differences in the technologies and the uptake, the methodology has been similar. The tendency has been to offer single prescriptions rather than options. There have not been detailed and objective evaluations of the technologies and the Department has not systematically worked with farmers on their

own farms to allow them evaluate the technologies. Thus, the Department has missed valuable opportunities relating to research, technology development, extension and teaching.

With this in mind, it seems particularly ironically that at Limuru, about 12 km from the Kabete Campus, there has been no obvious impact of the past decade of work relating to donkey harnesses in the Department. The neck harnessing systems widely used there appear to be inefficient and in some cases cruel. It seems it would have been an ideal location for participatory research with local farmers and transporters, in order that an efficient, affordable and acceptable harnessing system could be developed and adopted. Whatever the success (or failure) of such work, the technical and socio-economic problems encountered would have provided much valuable material for student projects, and for teaching about the reality of agricultural engineering problems in Kenya. In the last year, KENDAT has started to work with KSPCA in Limuru, and this appears a positive move that should benefit the Department.

On a more positive note, while attempts by the Department to train and assist harness-makers to establish viable businesses have not been very successful, this has been mainly due to low product demand rather than the methodology adopted. The training of harness-makers has illustrated that the Department has given significant attention to the problem of ensuring a sustainable supply of the new technology. Such supply-side concerns have often been neglected by other organisations promoting innovations.

Another very positive recent development has been the formation of KENDAT, which although it is an independent NGO, is currently co-ordinated from the Department, and it has benefited from the support of the Netherlands' project. KENDAT started with the rather out-moded ideas and methodologies that have been prevailing within the Department in the last decade (uncritical promotion of so-called "improved" yokes and harnesses). However, the national network is linked to the international network (ATNESA) and through workshops, publications and exchange visits, KENDAT has been learning of other experiences in the region, and of the importance of participatory methodologies. As noted, KENDAT now offers farmers / transporters a choice of harnessing options, not just one prescription. Furthermore, through KENDAT and ATNESA, the Department is now linked with research and extension programmes in several countries and with a number of world-class scientists and engineers. Such links have been largely missing in the past decade, and the prospects for the Department to live up to its international reputation in the field of animal power seem to have improved significantly in the past year.

In summary, work relating to harnessing in the Department started with much enthusiasm, but relatively little objectivity. Modest attempts at promotion based on non-participatory methods have continued almost unchanged since that time. The Department does not appear to have evaluated the technology rigorously nor has it analysed its own experiences critically. It does not appear to have kept abreast of current literature relating to either harnessing or to extension methodologies. In short, it has not made use of its acquired national and international reputation and its available expertise and contacts to provide professional leadership in this field. It is not too late for it to do so, and the recent formation of KENDAT, affiliated to ATNESA, has provided new ideas and impetus that could lead to a rapid improvement in the situation.

4.5 Staff & students

The majority of daily responsibilities in agricultural smallholder production are with the women, not with the men. On top of that, smallholder production is increasingly characterised by female headed households, especially in the ASAL areas. Many of the technological improvements and the relief of burdens in smallholder production are, thus, directly related to women. In that respect, the team observes a striking

discrepancy between the number of female students and the tasks the agricultural engineers should face (see Table 2). It must also be observed that none of the lecturers is female (JKUAT has two female staff, including one professor).

The reason for this male domination may be found in the combination of the 'engineering' curriculum that pays little attention to alpha-disciplines, and the fact that in Kenya very often separate high schools for boys and girls exist, where the female high schools pay less attention to beta-disciplines like mathematics, chemistry, etc.

Moreover, it should be observed that the intake and production of graduates and post-graduates is not based on any assessment of the requirements; the demand side has been neglected. Not only outside the University, but also inside, considering the favourable student / staff ratio.

This topic is discussed, concluded and recommended in more detail in the parts on curriculum development.

5 INSTITUTIONAL ASPECTS

The main institutional threats to the project and its orientation to have impact on production processes of the smallholder farmers are the Faculty of Engineering base, professional certification, equipment, and physical location.

Of a different but also institutional character, and highly relevant for the present situation, are the decision making processes that took place at the Department and with the Donor.

5.1 Faculty of Engineering academic base

The Department is caught between two stools. Its academic mother is the Faculty of Engineering. Its administrative mother is the Faculty of Agriculture. This means that its curricula and accreditation processes are controlled by the former. Naturally this implies that the emphasis in curricula and accreditation is seen basically in engineering terms. This tradition has been extended to the other two universities who have started departments of agricultural engineering. Egerton University essentially picked the existing Nairobi curriculum for this was easier than struggling to get the curricula accepted.

This influence is not just in terms of the structural arrangements of picking up an existing curriculum and implementing it. It is deepened by the personnel produced in the Nairobi system who have gone to the other universities as staff. They expand the Nairobi tradition. Nairobi graduates are found at Egerton University and JKUAT.

Faculties of Engineering are less tolerant of farmers, especially smallholder farmers, than Faculties of Agriculture.

We have not found evidence that the issue of academic base was ever raised by the donor. The Department staff is split on the issue. The majority seems to favour the current affiliation for they primarily see themselves as engineers. A small body of opinion thinks that they should be affiliated with agriculturists. What determines what opinion is held, seems to depend on whether the particular staff member came to agricultural engineering from engineering or from agriculture.

On balance, the opinion of the mission is that, from a national point of view, there is need for more farmer orientation over and above the needs of this project. This perhaps can only be assured by greater involvement with other farmer oriented departments found in the Faculty of Agriculture. Most of the Department's staff does not agree with this conclusion for they argue that they need the faculty of engineering to assure a certification.

5.2 Professional certification

In Kenya, one does not practice as an engineer unless one is registered by the Engineers Registration Board. This has career and income implications. The independent registration board, dominated by non-agricultural engineers, sets essentially engineering oriented criteria for certification. Thus, an agricultural engineer, who takes part in non-engineering concerns, is not fulfilling registration criteria. Like other professional boards, change comes slowly to this board. Hence the concern by staff that they assure that their products get certified by insisting on the engineering content in the curriculum, as well as by maintaining affiliation with the Faculty of Engineering.

5.3 Faculty of Engineering teaching equipment

To train students in the engineering component, the Department uses equipment of the Faculty of Engineering at the main campus. To date the Department has not acquired enough equipment to mount the courses on site. The mission has not found any formal document showing that the issue of providing the necessary equipment, independent of the Faculty of Engineering, was ever discussed. However, some of the old faculty members argue that it was considered and rejected at the beginning, 1976, for transporting students to the main campus was cheaper.

5.4 Student transport to the Faculty of Engineering

All students who have to take the engineering courses at the main campus, where the Faculty of Engineering is located, have to be transported. This is probably the major operational cost of the Department. Vehicles, bought and serviced by the project, have been the backbone of this activity. The university contribution to this activity has been negligible and is not likely to improve at project closure.

5.5 Decision making and team building by the Department

The Department is a relatively new organisation. It has grown very fast. Therefore, it exhibits all the organisational and managerial problems of a new organisation. Among these are lack of consultations, lack of acceptance of line authority, extreme individualist behaviour, lack of co-ordination, lack of agreed medium- and long-term strategies and suspicions. All these lead to extreme competition for recognition and status further militating against co-ordination, for all members are essentially age mates.

Problems of internal decision-making were recognised by both the 1985 and 1990 review missions. Both missions in different terminology called for changes in the management of the Department. One should though note that the solutions offered did not work for they did not address one of the key issues when an organisation has many conflicts. This is the issue of external facilitation, needed to let the organisation work through some key issues to build confidence in itself. Clearly the TA provided did not have these skills (they were not recruited to have such skills !), nor did they detach themselves from the Department to act as facilitators. Once an organisation solves a key problem, - in this Department the long-term research strategy or the revision of the curricula systematically fall into the key categories -, it builds confidence in itself to tackle ordinary problems.

The 1985 mission called for establishing guidelines on leaves of absence, changing teaching methods, setting national research priority areas, creation of a research committee, ascertaining transfer of knowledge methods to farmers, supervision of graduates in the field, networking, and training staff for other universities. Other than the last one, which was to happen whether the Department did anything or not, the other recommendations have not been acted upon by a process that includes discussion and consensus by the faculty members. Individuals have taken initiative on some issues and run with them.

The 1990 mission pointed out that the Project Co-ordinator prepares project proposals and reports and that they are sent out under the signature of the Chairman without much discussion by the other staff members. It also stated that research on animal power ought to take priority over extension for the scientific basis of the activity had not been established. Decision making on project funds was mainly done by the Project Co-ordinator and the Chairman. Operational expenditures of the Department were from the

project and the Department was supposed to look for alternatives. The Department was supposed to develop a comprehensive and medium to long term research programme.

Issues of participative consultations in decision-making for team building within the Department were central in the recommendations of the 1990 Mission. It pointed out that the Department should "begin evolving a permanent departmental process to:

- 1. Execute agreed departmental plans without seeing them as only derived from either the section heads, the senior scholars or the chairman personally.
- 2. Plan long term training, research, and contract consultancy strategy.
- 3. Manage conflicts arising out of competition for resources within the Department, particularly inter-sectional competition between the three sections, namely, Agricultural Power and Machinery, Agricultural Processing and Structures and Soil and Water Engineering".

To facilitate this, the Department was to formalise the Executive Committee, made up of the Chairman and the three section heads and to create two staff committees, namely Research Committee and the Education Committee. The mission advocated these committees for key decisions were made or are perceived to have been made without staff consultation. Staff consequently either fight the decisions or distance themselves from them. The case of animal draft was cited.

The Department duly created the two committees. The whole Department organised a retreat in Masinga in 1991 to pursue the recommendations of the 1990 mission, particularly those related to a long-term strategic plan. All members of the Department we have talked to argue the four-day meeting was a failure for they could not reach agreement. Moreover, since many staff members had not made preliminary proposals on research and extension of the project, the final document was seen as only the ideas of the Chairman of the Committee. The mission has been told by some members that they were so disgusted they decided it was up to the Chairman and the Co-ordinator to produce the document that went to the Embassy. Even more serious was the conclusion by some that it was the responsibility of some sections to work on it for other sections already had other donor money (from SAREC). This position still holds. Those so divorced now argue they have evidence that the other section could not develop a strategic plan that could be funded. The general opinion seems to feel that this Committee is moribund.

Again, in November 1994, the Department met to consider revision of the BSc curriculum that had been revised to cater to the 8.4.5. in 1990/91. A large body of staff claims this only added more theory courses, though they had invited farmers and other consumers of the Department product to the meeting. There was no systematic output on which all are agreed. Most staff members claim not to have seen the output. Perhaps the most serious evidence of lack of co-operation among staff is a request that they be paid to complete the revision of the curriculum.

Some in the Department explain the extreme lack of co-operation as a result of the aftermath of the University strike in 1992 when the state brutalised university lecturers in general. It is worth noting that inflation and devaluation in 1993 and 1994 seriously eroded the incomes of salaried employees, university staff included. This coupled with the negative response to the state's reaction to staff demands in 1992, among which was the issue of salaries, has led to general demoralisation. Many now have outside jobs or consultancies.

The problems militating against team approach enumerated above are real. However, this mission is of the view that in the situation of extreme uncertainty, which the country and the university underwent over the past three or four years, the organisations with systematic co-ordinated strategic plans are the ones likely to survive as entities. Of course some individuals in the Department are doing well for they have research money. Some have established good consulting practices. It should be clear to

all though that uncoordinated efforts, however important to individuals, do not lead to the survival of the organisation, the Department, which in the long term assures their welfare even in consulting.

5.6 Decision making by the Donor

The decision making process at the donor side is more difficult to evaluate. First, the files at the RNE do not cover the entire project period and in the second place, much decision making was done in a rather informal way and is not fully documented. This means that arguments used are often unclear or unavailable and that only the end product (like e.g. the Bemo or Appraisal Memorandum for Phase IV) is obtainable. This Bemo gives little or no indication which arguments and considerations have been used to arrive at the phase out decision. The Bemo is based on some general and rather optimistic assumptions that lack sufficient support.

Some examples of this are (Translated from the Dutch):

- The proposed project contains a sustainable reinforcement of the quality of the faculty, staff and facilities....(page 5, 1).
- After this, the faculty will have to be able to function independently....(page 5, 1.1.1).
- The proposed workplan already incorporates facilities to ensure continuation at the same level after termination of the Netherlands support....(page 6, 1.2.2)

Circumstantial evidence, however, makes it probable that the project has operated in the margins of the bilateral development co-operation package between Kenya and the Netherlands. In a rather systematic way was the project assigned to young and newly arriving diplomats, who encountered the project as one of their first experiences with development co-operation. Interviews on the telephone with some of these diplomats now stationed in places far away from Kenya, confirmed this impression.

The interviews also made clear that the project was looked upon as one of narrowly defined institution building. The project was about the administration of staff to be trained abroad, about expats who had to supplement lecturing capacity, and buildings and equipment to be provided. This implies that the long-term objective of the project seems to be forgotten a long time ago by the donor, at least by the middle of the 1980s. The character of the project was remembered as a 'topping up' one, where contents hardly played a role. It was in essence looked upon as an administrative project that was well organised and administered (that, thus, could be handled by diplomats with little development co-operation experience). It is no wonder that most contacts were between the expatriate staff and the financial administration at the RNE.

Also in the 1990s, when the decision was taken to phase out, the project was never really discussed - isolated as it was from the mainstream of the bilateral development co-operation effort. It just seemed logical in 1991, after so long a period, to phase it out, which decision was communicated to the desk in The Hague. Apparently the desk accepted and stated in the Bemo on top of page 3 that the project is one of the "programmes that no longer have priority in the regional development policies".

It must be observed that once this decision was taken, the phasing out was done in a proper, generous and patient way by the donor. Noteworthy is though that the character of the final phase was to prepare the Department for the future that would lack the support of the Netherlands Government.

In line with this character is the fact the last expatriate was initially supposed to phase out early in this final phase, after about a year. In the end, he remained several years longer, until the very end of the project. The related decision making is not transparent.

6 SUSTAINABILITY

6.1 GoK

The funds supplied by the GoK have always been insufficient to run a Department of this size and this is not likely to improve. Besides the lack of operational funds, funding for the maintenance of buildings and equipment is, at the moment, totally inadequate. Even bleaker is the picture for (the replacement of) equipment and other assets of the Department, since depreciation is a vote unknown in the budgetary system.

At present, three Universities are equipped with a Department of agricultural engineering. The number of students graduating and lecturers employed is far too high compared with the demand side. Also this fact of over-capacity makes it improbable that GoK will ever be able to adequately finance this or any other Department of agricultural engineering.

The Department can partly survive with the support provided by SAREC (now merged into Sida) during 1996 and 1997, although earmarked for the Soil and Water section of the Department. However, if donor dependency persists while the GoK cannot deliver, the Department will, after 1997, rapidly decay and disintegrate.

To a certain degree, the Department is already disintegrating. The fact that the GoK blocked (after a one-year strike) the formation of a Union, strongly de motivated the staff putting into danger the future existence. The overall loyalty of the staff demonstrated by coming back after graduating abroad, has now given way to an overall little commitment for the Department and a very individual attitude for survival.

Although informed by the Chairman in advance, most of the lecturers were not available to the review team, and the debriefing was attended by six Kenyan staff members only.

6.2 Lecturers

The lack of motivation combined with the economic reality that, especially since 1993, the salaries are insufficient to survive, created the situation that most of the lecturers are hardly present at the Department, except for the hours that they are teaching. Several of them are registered as a private consulting company and work as such. It is not exaggerated to state that the main occupation of the staff is consultancies (this could open opportunities for the future though).

Apparently this survival approach has been accepted by the management. Even stronger, as indicated earlier, the required change in the curriculum of the Department was refused to be executed by the staff unless they get paid for it, and this principle of getting paid for such tasks has been excepted by the management of the Faculty (although the funds are not available and no change will be effectuated).

6.3 Future

No substantial or departmental vision related to the future exists other than the hope for a new donor and the attempt to also 'open' the Soil and Water section (supported by Sida / SAREC) to lecturers in the two other sections of "Farm Power & Machinery" and "Processing & Storage".

By consequence, no strategic plan incl. curriculum, research/extension, intake, etc. exists, as explained earlier.

On an individual basis, some of the lecturers have some ideas related to income generating activities but all put together, these are by far insufficient to rescue the Department as it is now.

Yet, generation of income is in principle possible according to the parastatal status of the University.

7 CONCLUSION AND RECOMMENDATIONS

7.1 The concept of the project

It can be concluded that the project 'missed' the important developments in the thinking about agricultural production in sub-Saharan Africa or Eastern Africa for that matter, especially during the 1990s. Neither the Department, nor the expatriate staff or the donor observed or acted upon this. What was the common thinking at the start of the project is no longer in force.

- In order to better serve the purpose of sustainable agriculture the Department should develop a smallholder farmer oriented approach (see § 7.2 for details).

The review team feels supported in this key recommendation by J.G. Speth, the Administrator of UNDP by 1993. In the Sir John Crawford Memorial Lecture he gave on 25 October 1993 to the Consultative Group on International Agricultural Research (CGIAR), he stated (page 5 of the transcript):

"Our development work must also include real participation of and ownership by the beneficiaries of development. Top-down development is out. Development can be achieved only where people have an opportunity to participate in the events and processes that shape their lives;"

And:

"You [...] have demonstrated your abilities to carry your research into farmers' fields through your extensive farming systems research efforts. As you plan and implement eco-regional and other research programmes, the participatory process must be strengthened. Small farmers and local organisations must be involved from the identification of problems and the first planning exercises. They must become co-owners of the research by clearly identifying their needs, by relating their past experiences and indigenous knowledge in meeting these needs, and by participating in the research process."

7.2 Achievements

7.2.1 Curriculum

The project has from the beginning focused on assuring that it produced teaching staff cloned from the international definition of an Agricultural Engineer. This product was to produce a curriculum again accepted by his peers internationally. These are two clear successes. However, the produced staff did not have the orientation towards the smallholder problems, for the training system they took part in was not so oriented.

The project on its part did not insist on this criterion although it is found in the documents. Consequently the curriculum has little practical farmer oriented, bottom up content. The outputs of the curriculum at the graduate level end up in supervisory levels with limited farmer contact. The BSc level outputs, according to limited interviews, end up learning about farmers on the job.

They pick up socio-economic analytical skills on the job. Given the staff training, especially the concentration on the advanced technological systems in US universities, their interest is in those technological large scale activities, which lend themselves to technological solutions is not surprising. Their contribution, for example, to coffee

7 CONCLUSION AND RECOMMENDATIONS

7.1 The concept of the project

7.2 Achievements

7.2.1 Curriculum

7.2.2 Research, theses and other publications

7.2.3 Animal Draft Power

7.2.4 Staff & students

7.3 Institutional aspects

7.3.1 Employment

7.3.2 Faculty of Engineering or Agriculture

7.4 Sustainability

7.5 Synthesis of recommendations and conclusions

7.5.1 Changed concept

7.5.2 Income generation

7.5.3 Justification

Table 1 *Topics for theses by MSc students (§2.2)*

Table 2 *Staff trained (§2.5)*

Table 3 *Students trained at the Department of Agricultural Engineering UON (§2.5)*

Table 4 *Differences in looking at agricultural development (§ 3.2)*

Table 5 *Employment opportunities at the MoA (§ 7.3.1)*

Annex I Terms of Reference

Annex II Itinerary and Persons met

Annex III List of Staff

Annex IV List of Publications

Annex V Comments by the Academic Staff on the Draft Report

processing, pyrethrum drying, maize storage and estate sugar production has been significant precisely for that reason.

TRANSCRIPT OF AN INTERVIEW

CASE ONE

I was born in _____ among the pastoralists. When I came to the university I wanted to do agricultural engineering so that I could help my people solve some of the animal watering problems. I did not get much along these lines. The only time animals were mentioned was in the courses on Farm Management and Extension. Farm management and extension apply to the high rainfall areas and they really are not of much use to pastoralists. I always wonder why the curriculum ignores the problems of the dry areas that are the sources of meat nationally. There are very few slaughter animals in the high potential areas.....Of course it is true we touched on animals in the Farm Structures course when we were designing zero grazing houses. We also took part in some demonstrations of ploughing by animals.....

I graduated with a BSc in 1990. After graduation I went to work for National Irrigation Board scheme in _____. I think we should have started to specialise by the second year. This way perhaps we could have learned more about irrigation and drainage..... Nobody taught me how to handle farmers, especially the old people. Although I like the work, the scheme has many problems teaching farmers. We want to introduce other crops. We have had to meet with farmers to discuss this programme..... We got general lectures on extension. This was not specific for irrigation. We are learning in the field how to work with farmers. My colleagues are the ones who teach me about economic and social analysis for they have been in the field longer than me. The curriculum should have included dealing with officials and farmers.....

I would like to go back to university. I have applied for a scholarship. I want to study more.

The strong conclusion then is that the Department has not seen fit to include matters of smallholder production as a central focus in its training. Second, there are too many theoretical courses, especially at the BSc Level. This fact is recognised in the Department but attempts to revise the BSc curriculum are bogged down in the personalised departmental decision-making style that has seen faculty members fight over the revisions for the past two years.

It is the opinion of this mission that the Department should build on the inconclusive discussions about the strategic plan and curriculum revision. A donor can facilitate this by offering a consultant with organisational development skills ('manager of change') to help the Department go through team building process to develop these very key documents for its survival. The procedure should be as follows: all staff members should be required to prepare proposals for circulation to all other staff members. After an interval of study individually, these should be discussed within the sections so that the sections can agree on section priorities. Again, these should be circulated to all staff members and sufficient time allowed for individual study. Finally the Research and

Education committees should prepare a document before calling the whole Department to a retreat to complete departmental proposals. These should be circulated to all staff members and sufficient time given for study. The Department should then meet to discuss what to adopt.

Such a process in Team Building, assisted and facilitated by an external organisational development practitioner ('manager of change'), ought to affirm to the Department their own confidence for part of the lack of tolerance and co-ordination is partly failure to rise to the common good because of lack of confidence in the institution.

- There are too many courses. Perhaps a reduction by about 60% will be in order.
- There clearly is need for a re-orientation; to increase courses on economics and sociology for agricultural engineering takes place in society.
- During this reduction and reconstitution of the curriculum contents, there should be planned systematic practicals with participatory techniques in the time saved. Such practicals should recognise the centrality of smallholder production in the national economy. The recommendation simply means that all curricula should have more extensive time devoted to practical activities in teaching and research in the field. Such activities should be spread through all Kenyan farming systems with special attention to smallholder production systems that accounts for more than 80 % of the total national agricultural production.
- If training abroad cannot be avoided, practical field work to be done in Kenya through sandwich formulae
- Lecturers and students are to be trained in PRA and PTD techniques.
- Also the graduated ones are to be trained if possible, e.g. through the establishment of an Alumni Association through seminars workshops and participation in (KARI) FS teams.
- Instead of a(n) expatriate lecturer(s) that has no other added value than to complement lecturing capacity and watch the money, assign a 'manager of change' for one or two years to take care of the re-orientation.
- Networking is to be supported (important as future channel for FS based experiments and training experiences).

7.2.2 Research, theses and other publications

general

In conclusion it appears that, while individual staff members are clearly capable of undertaking research in a conducive environment with clear leadership, such conditions have yet to be created within the Department.

- The 'manager of change' c(sh)ould also be instrumental in this respect.
- A strategic research plan has the utmost priority and should be developed keeping in mind the relevance for the smallholder production sector. It would mean that the deliberate choice has to be made that the relevance for the societal needs will have to prevail over the 'academic freedom'.
- This should also imply that the topics selected for theses by students will have to fit the same strategic framework.
- More bottom-up/farming systems should form the basis (synergy with Dutch support to research and extension) for new applied research projects.
- Link research / field work to existing GoK programmes in e.g. KARI.
- Re-orient identification of research projects and finish the ones now accepted.

It must be underlined that the focus on the predominant needs of the agricultural production sector in Kenya at the cost of the academic freedom, in no way implies that the standard or level of the research will (have to) go down.

Specific Animal Draft Power

Work relating to harnessing (and other animal draft technologies) in the Department started with much enthusiasm, but relatively little objectivity. Modest attempts at promotion based on non-participatory methods have continued almost unchanged since that time. The Department does not appear to have evaluated the technology rigorously nor has it analysed its own experiences critically. It does not appear to have kept abreast of current literature relating to either harnessing technologies or to extension methodologies. In short, it has not made use of its acquired national and international reputation and its available expertise and contacts to provide professional leadership in this field. It is not too late for it to do so, and the recent formation of KENDAT, affiliated to ATNESA, has provided new ideas and impetus that could lead to a rapid improvement in the situation.

- Animal Draft Power should remain an important component of the Department's research, teaching and out-reach programmes.
- However the topic could benefit from both a participatory approach and national / international networking collaboration.
- Department staff, in co-operation with KENDAT and colleagues from Egerton, JKUAT and KARI, should critically review the present status of animal draft technology in Kenya, collating existing information and identifying priority areas for participatory research-extension and teaching/training requirements.
- Current thinking in animal traction research, extension and training should be included as topics in the proposed "reorientation" exercise within the Department.
- The experiences of the Department in harnessing be critically reviewed and analysed and published as a valuable case history for the region (perhaps in collaboration with ATNESA and / or KENDAT). This would also be a valuable teaching aid.
- The Department should undertake a review of harnessing systems and select a range of options for donkeys for participatory testing with farmers / transporters in the vicinity of Nairobi, with economic acceptability being a key criterion for success. This work could be carried out in association with KENDAT and / or interested NGOs. This could also provide valuable lessons for students.
- If a member of staff or student were interested, running parallel to the other harnessing work, a series of objective, replicated trials on harnessing might be carried out using data-logging instrumentation techniques. Prior to any such research, a thorough review of previous trials world-wide should be made, and contacts be made with researchers at the Universities of Edinburgh, Hohenheim and Cornell who have implemented comparable trials (contacts available through ATNESA / KENDAT).
- Those responsible for implementing the Animal Draft Power Project in Homa Bay, should be given a chance to learn about the participatory methods employed by projects and organisations, e.g. those described earlier in § 4.4.

topics for theses

The small number of theses' topics that is relevant for the smallholder production and, thus for the fulfilment of the long-term objective leads to the conclusion that a research strategy and priority setting are urgently required.

- The recommendation made in this respect in earlier reviews and earlier in this review, is repeated and underlined.

7.3 Institutional aspects

7.3.1 Employment

After 20 years of implementing this project, this mission finds it remarkable that nobody has any quantitative data on the national demand for agricultural engineers. Nobody seems to have any quantitative data on utilisation of the supply since the beginning of the project. Two other universities have started programmes in agricultural engineering without establishing demand and specifying what training levels were needed. Such specification would assist in settling some of the institutional problems specified above.

Second, we have evidence from interviews that graduates are beginning to have problems getting jobs. Although not stated, it appears the project assumption was that most graduates will be employed by the Ministry of Agriculture. Given the dictates of Structural Adjustment, this is no longer possible and we project that many graduates, like their other professional colleagues, the Veterinarians, will increasingly not get jobs in the public sector. From this, the obvious conclusion is that Agricultural Engineers are being trained for self employment or employment in the private sector.

TRANSCRIPT OF AN INTERVIEW

CASE 2

I finished the BSc in 1988. I wanted to work for a multinational, for the pay and work conditions are good. Therefore when _____ advertised I applied and was employed. They are part of Unilever..... The training gave me a broad perspective. I was able to pick up on the products we sell. The basic engineering was good. _____ cut down on training us for we are engineering literate. We understood pumps, engines and irrigation. All three of us who graduated the same year are employed as salesmen. We do not do any design or fabrication work for our company brings everything almost ready. Whatever has to be assembled is done by technicians and mechanics.The three of us have not sought registration as engineers by the Engineers Registration Board. We do not need it. Our promotion is dependent on how we do in the internal training programme that is one of the best in the world. I have not stayed in contact with the Department. In the back of my mind I have always thought of going back to school for an MBA in marketing. The problem is sponsorship.

None of us are members of the Association of Agricultural Engineers. We have tried to assist it by internally speaking to the top managers to give it sponsorship.....Other than the three of us here, I know about five other classmates. _____ is an academic at the university. _____ worked for the Ministry of Agriculture and now is a consultant on coffee factories. _____ was working for a small business development organisation since we left the university but next month he will be working as a salesman for _____, which is a multinational selling equipment. _____ is working for a tyre company in sales. _____ is farming

The mission believes that the problem of tracking graduates, both BSc and MSc, has now become extremely urgent.

- Tracking is needed to establish which components of the Department are marketable and how much engineering or agriculture is needed in the products.
- Over and above a detailed tracking study, there is need for a national agricultural engineering personnel demand study.

Both studies should be done immediately and should cover the three universities producing agricultural engineers and preferably of total samples for they are estimated to be less than 500.

- Depending on the conclusions of these two studies critical decisions need to be made about the institutional set up of training.

7.3.2 Faculty of Engineering or Agriculture

The mission is of the view that, to fulfil long term needs of smallholders, there is a more likely chance of focusing the training on them if the Agricultural Engineering Department is academically in the Faculty of Agriculture.

- Transporting students to take courses in the centre of Nairobi is not sustainable. Why is it that the students are not housed in the main campus when they need to be trained in the Faculty of Engineering to cut out transportation? Can scheduling of courses be changed to facilitate this?
- The mission is of the opinion that the Department and all other Universities offering agricultural engineering should make presentations to the Engineers Registration Board to accept their being housed in Faculty of Agriculture.
- If this is not acceptable, they should make representations to the state for independent registration of Agricultural Engineers under a board which does not include other engineers.
- Some of the professionals in other universities argue that there should be specialisation of the three universities. This should be explored now if it leads to reduced operating costs and relevance.
- Presentations should be made to the government, other donors financing the Department, and the Netherlands, to finance the equipment to facilitate locating all training on the Kabete Campus under the Faculty of Agriculture, for transporting the increasing numbers will not be sustainable.

7.4 Sustainability

It must be concluded that the result of 20 years support is neither adequate to serve the actual demands in agricultural production, nor is it very sustainable. For the latter, the project cannot be blamed exclusively, also (f)actors beyond control of the project or donor or Department played an important role, like the ever reducing GoK contributions, the University strike, etc.

There seems no reason to expect that the GoK can change its financial policy towards the Universities, and the search for another 'horse' (donor) to switch to will only push the problem of sustainability forward.

The fact that several lecturers are already actively engaged in consultancies might provide the solution. It seems the obvious and only way to go for the Department. The *conditio sine qua non* is that the individual approach is left behind and that the staff starts operating as a team: as a professional consultancy group; an internal matter. Team holds the opinion that skills building is an important aspect of such a process and should be part of the overall re-orientation.

- A serious effort is to be given to re-orient the capabilities of the staff.

- Training of the lecturers in consultancy skills (acquisition, proposal writing, budgeting, etc.) might greatly assist the sustainability.
- Training in entrepreneurial skills is important in this (to be combined with the manager of change mentioned earlier).
- The establishment of a package of short courses to be given by the staff has potential for the generation of income. A renowned institute like the IAC / Wageningen could be of assistance to build this up.

7.5 Synthesis of recommendations and conclusions

Most of the recommendations refer to the Department; those will not be synthesised. The team tried to make it clear that basically these are the most important recommendations that have to be picked up by the staff of the Department: a change in attitude is required if the Department wants to survive. In general, all recommendations relate to such a change.

In case the staff is prepared to do so, it might be worthwhile to consider outside support: external financial support and external management support for re-orientation. This final part briefly summarises required outside input.

Outside support should focus on two major issues: the consequences of the changed concept necessitating a re-orientation of training, curricula, research approach, etc., and the reality that without institutional income generation, the future looks bleak indeed. The latter necessitates capacity building in consultancy and entrepreneurial skills.

7.5.2 Changed concept

- Support for transition (to a Department that delivers what is required) during the next two years while there is some sort of protection due to the Sida / SAREC input to one section of the Department.
- Joint venture with Sida?
- Assignment of a manager of change.
- This transition requires re-orientation of the staff through additional training (PRA, PTD, socio-economics, etc.) in workshops, seminars and short courses.
- Linking up with KARI's FS teams for farmer oriented practice periods.
- Similar re-orientation for 375 graduates.
- Possibly through establishment of Alumni Association.
- The transition also requires changes in the curricula.

7.5.2 Income generation

- As all over the world, also the Department will have to generate income.
- The manager of change is to support the Department to re-orient itself from passive donor dependency to active, institutional income generation.
- The most obvious opportunity is in the field of consultancies.
- Training to improve such consultancy skills is required.
- Training in entrepreneurial skills is required.
- The Department could be assisted (IAC?) to develop training courses.

7.5.3 Justification

The Department could approach various donors for assistance in the implementation of the points under the two previous paragraphs. Yet, despite the end of project character of this review, the team holds the opinion that there is some justification for the Netherlands Government to consider such support. In case a joint venture with Sida is possible, such support might not have to take the shape of a new 'project'.

The following arguments can be raised:

- First 10-15 years spent in building up critical mass of staff. The Department de facto existed around 1990.
- NL staff did not facilitate external contacts / expertise.
- GoN at present pays major attention to research (KARI) and extension (WEKASP); it seems logic not to ignore the third component of training. It is known that the way researchers and extensionists are trained creates a constraint to the desired changes in research and extension approaches.
- The new participatory and FS approaches in agricultural research and extension know a 'gap' where technologies are concerned; this makes the proposed re-orientation of agricultural engineering important.
- The gender aspect, since distinctive technologies are specifically related to women.

Annex I Terms of Reference

TERMS OF REFERENCE

For the end of project report of the "Assistance to the Department of Agricultural Engineering University of Nairobi (Phase IV)" (KE092030)

A. Background

(a) Objectives

The objectives of the Netherlands bilateral support to the Faculty of Agricultural Engineering of the University of Nairobi are twofold. The long term objective is to improve the carrying capacity of agricultural lands in Kenya and increasing agricultural production, through the use of technically and environmentally sound agricultural techniques, based on local technical expertise, thereby contributing to a reduction of poverty. The short term objective is to establish an adequate and sustainable educational structure in the field of agricultural engineering through the institutional strengthening of the Department by way of staff development and training, and the provision of general material support, to be achieved on the basis of a gradually reduced level of Netherlands' support during Phase IV, being the final phase of the project.

(b) Target groups

The target group for the long term objective are smallholder farmers, whereas for the short term objectives the target groups are the staff and the students of the Department of Agricultural Engineering.

(c) Project Phases

The project has completed three phases of Netherlands support and is now in the final year of phase IV. During phase I (1976-1981) the focus was mainly on developing the B.Sc. Agricultural Engineering curriculum and to launch post-graduate diploma courses in Irrigation and Soil Conservation. To serve that purpose, supernumerary teaching posts were provided as well as scholarships for staff development abroad and material inputs locally. Supplementary support was provided to construct offices and laboratories for the Department of Agricultural Engineering, which was founded in 1974.

During phase II (1981-1987), the B.Sc. Agric. Eng. was further consolidated and research work was started with the start of the Animal Draught Power Measurement Project which was integrated into the departmental activities in 1985. This research project had two basic concerns:

1. the production of improved harnesses for oxen and donkeys;
2. the extension of this technology to farmers.

The research project has continued to date (the research project itself has not received funding through Phase IV of the project. However, the research project benefited indirectly from the budget allocation for "education and research support facilities").

Phase III (1987-1992) had the objective to establish a M.Sc. programme in Agric. Eng. and an integrated research programme in this discipline. The building facilities were expanded to meet the growing needs.

Phase IV has the objective to phase out the long-lasting Netherlands institutional support in such a way that the Department will be able to continue its activities after Dutch assistance has ended.

Major activities during Phase IV are:

- a. Training four academic staff members to Ph.D. level;
- b. Providing an expatriate lecturer and project co-ordinator;
- c. Providing supernumerary lecturers recruited locally;
- d. Providing short term consultants;
- e. Providing teaching materials and research instruments;
- f. Providing training for technicians;
- g. Providing books and journals;
- h. Providing equipment and other support for developing and publishing teaching materials;
- i. Providing general support on a declining basis.

The project was reviewed in October 1982 (by A.F. Fowler and K. Kinyanjui), in August 1985 (by J.W. Kijne, D.B. Thomas, J. de Meyere, E.N. Mwaura, A.F. Fowler) and in November 1990 (by G.W. Peter, L. Speelman, F.J. Wang'ati, G.C.M. Mutiso).

B. Tasks

The review mission will undertake the tasks stipulated under (a) to (f) below with the aim of drafting an 'end of project report' focusing on the project results in relation to short term objectives and lessons learnt, and on strategies to be developed by the Department to guarantee the sustainability of the project and its achievements after the end of the Netherlands support programme on January 1st, 1996.

- (a) Achievement of short term objectives:
 - what has been the efficiency with which the project has been implemented, taking into account the following criteria:
 - i. the number of staff trained (with special emphasis on gender) and career perspectives of staff trained; what has been the impact of the project on the staff;

ABBREVIATIONS AND ACRONYMS

ADP	Animal Draft Power
AGROTEC	Agricultural Operations Technology for Small Holders in Eastern and Southern Africa
ASAL	Arid and Semi-Arid Lands
ATNESA	Animal Traction Network for Eastern and Southern Africa
BSc	Bachelor of Science
DAREP	Dryland Agricultural Research and Extension Project
DDCU	District Demonstration and Contracting Unit
FAO	Food and Agriculture Organisation (of the UN)
FS	Farming Systems
FSA	Farming Systems Approach
FSR	Farming Systems Research
GoK	Government of Kenya
GoN	Government of the Netherlands
IAC	International Agricultural Centre (Wageningen, Netherlands)
IRDC	International Rural Development Centre (of SUAS)
ISNAR	International Service for National Agricultural Research
JICA	Japan International Co-operation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kenya Agricultural Research Institute
KENDAT	Kenya Network for Draft Animal Technology
KSAE	Kenyan Society of Agricultural Engineers
KSPCA	Kenya Society for the Protection and Care of Animals
LEISA	Low External Input Sustainable Agriculture
MoA	Ministry of Agriculture
MOALD&M	Ministry of Agriculture, Livestock Development and Marketing (Kenya)
MSc	Master of Science
NALRP	National Agriculture and Livestock Research Programme (Tanzania)
NAMA	Network for Agricultural Mechanisation in Africa
NARO	National Agricultural Research Organisation (Uganda)
NARP	National Agricultural Research Programme (Kenya)
NGO	Non governmental organisation
OPS	Office for Project Services
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
RNE	Royal Netherlands Embassy
RRA	Rapid Rural Appraisal
RSCU	Regional Soil Conservation Unit (SIDA)
SAESA	Society of Agricultural Engineers in Southern and Eastern Africa
SAP	Structural Adjustment Programme
SCIP	Smallholder / Second Coffee Improvement Project
SIDA	Swedish International Development Authority
Sida	Swedish International Development Co-operation Agency (merger of a.o. SIDA and SAREC)
SIDP	Smallholder Irrigation Development Project
SUAS	Swedish University for Agricultural Sciences (in Uppsala)
T&V	Training and Visit (extension system)
TA	Technical Assistance
ToR	Terms of Reference
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UON	University of Nairobi

- ii. the number of graduates and the nature of the jobs found by them (with special emphasis on gender); what has been the impact of the project on the students;
- iii. the contribution of the project towards research and development in terms of:

- in post harvest technology;
- mechanisation including animal draft power;
- soil & water engineering;
- harnessing
- to what extent has the project supported the department in the execution of teaching and research programmes?
- what is the extent to which collaboration with other Departments, the Ministry of Agriculture, NGO's and local manufacturers contributed to the fulfilment of the short term objectives?
- to what extent has knowledge been transmitted from the staff/students to the farmers?

(b) Project execution:

- has the execution of the project in terms of lecturer/staff inputs and material inputs, including tools and equipment, facilitated and contributed to the developments in (a), and were inputs supplied as scheduled?

(c) Programme Sustainability

- taking into account the twenty years of project life, are the institutional developments, the linkages and associated programmes appropriate and sustainable, in view of - among others - the low budgetary allocation by the Government of Kenya?
- to what extent has the project been able to develop income generating capacities to improve its long term financial sustainability? If so, how successful have these capacities proved to be?

(d) Various

- which are the particular strengths and weaknesses of the project?
- which are the other positive or negative impacts of the project (including, but not limited to, environmental, economic, social and gender considerations)?

(e) Lessons Learnt

- which are the key lessons of the project regarding the points (a) up to (c) above?
- How relevant are these lessons to Kenya and other countries in the region?

(f) Recommendations

- how should the Department utilize the infrastructure, human capacity and linkages developed by the project to:
 - i. contribute effectively to rural development initiatives?
 - ii. address gender and environmental issues pertaining to the achievement of both long term and short term objectives?
 - iii. create income generating methods enhancing the financial sustainability of the project after the end of the Netherlands' support?
- which are the potential areas for follow-up programmes to be presented to potential donor agencies. How might these follow-up programmes help maximise the returns to past project investments?

C. Methodology

The review team will develop its own methodology in consultation with various interested partners. However, the team will review the project document, project reports and publications, earlier review and evaluation reports (see above A), consult the people concerned (staff, students, Ministry of Agriculture, University of Nairobi, governmental organisations, RNE, NGO's, harness makers, implement producers, small-holder farmers (including but not limited to users of animal traction related products developed by the project.)

D. Outputs

The review team will prepare a draft final report, to be submitted to the project, RNE and DGIS for their comments. The draft final report should be received by the project, RNE and DGIS on or before 29 December 1995.

E. Duration

The duration of the mission will be ten days in Kenya.

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Annex II Itinerary and Persons met

ITINERARY & PERSONS MET

<u>date</u>	<u>place</u>	<u>met</u>	<u>function</u>
Wednesday 13/12	Dep Agr. Eng. UON do do	Dr. E Mwaura Mr. L Oudman Dr G Muchiri	Chairman Department project co-ordinator Sr. Lecturer UON
Thursday 14/12	Dep Agr. Eng. UON do do	Dr. E Mwaura Dr. F Gichuki Mr. L Biamah	Chairman Department Lecturer Lecturer
Friday 15/12	JKUAT ¹ do do do do do do do do do do	Dr. E Gumbe Dr. I Inoti Dr. B Mwaka Mr. M Abdulahi Mr. D Muturi Dr C Nindo Dr. J Nozaka Ms M Kaber J Kamanuya Ms J Okalebo Mr A Karimi	Sr. Lecturer UON Lecturer JKUAT Lecturer Egerton Mwea Irr. Scheme NIB Lecturer UON Chairman Dep Ag Eng. JKUAT Techn. Advisor MSc student UON BSc graduate UON BSc graduate JKUAT Technician UON
Saturday 16/12	Panafric Hotel do		team discussions report writing
Sunday 17/12 ²	Panafric Hotel/offices		report writing travel to Homa Bay
Monday 18/12	Faculty of Agriculture Gailey & Roberts offices	Dr. P Mbugua Mr. C Maina	ag. Dean sales executive report writing
Tuesday 19/12	Plan Int. Kiambu office MoALD Land Man. Div. MoALD Land Man. Div. MoALD Land Man. Div. offices	Mr. F. Kachwe Dr. C Oso Mr. H Mwathe Mr F Mbote	development advisor Dep. Director Head, Irr. & Drainage Head Soil & Water report writing
Wednesday 20/12	office SCIP/MoALD/WB Sida/SAREC DGIS	Mr. R Toka Otolo Mr. T Anyengo Mr. M Koper	team discussion project engineer programme officer former resp. RNE NBO
Thursday 21/12	office office Dep Agr. Eng. UON	Dr. P Kaumbutho staff Dep, Mr. F Mollen	lecturer preparation de-briefing debriefing
Friday 22/12	office DGIS	Ms. R Bus	report writing do

¹ Conference of Kenya Society of Agricultural Engineers

² For the trip to Homa Bay the team split up. Mr. Starkey went on safari, the two other team members continued in Nairobi and environs

On Sunday 17 December, a supplementary itinerary started. On that day, one of the team members visited Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay. On the following Monday Malela Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay was visited, and on Tuesday thereafter the trip continued to Kilgoris.

During the field trip to Homa Bay, the following persons were contacted by Mr. P Starkey

Mr J Opiyo	Technician, Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Mr. J Ouko	Technician, Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Ms R Akumu Asiyio	Donkey-using trainer, Adiedo, Kendu Bay
Mr. J Ochieng Malil	Farmer / transporter, Otok, Kendu Bay
Mr. R Ayoko	Farmer, Kadet, Kendu Bay
Mr. P Otul	Technician, Malela Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Mr. C Ayingi	Farmer, Malela, Homa Bay
Ms A Anyan'go	Farmer, Malela, Homa Bay
Mr A Habil Olando	Farmer, Ogongo
Mr J O Agak	Farmer, Ogongo
Mr G Kodwaro	Draft Animal Project Co-ordinator, Homa Bay
Mr T Mboya Owiyo	assistant Draft Animal Project Co-ordinator, Homa Bay
Mr B Okinyi	graduate assistant, Draft Animal Project, Homa Bay
Mr B Ombogo	District Mechanisation Officer, Kilgoris
Dr P Ondieki	Veterinary Officer, Kilgoris

During a field visit to Limuru on Wednesday, Mr. P Mwaniki a transporter / carpenter was visited.

Annex III List of Staff

DEPARTMENT OF AGRICULTURAL ENGINEERING

STAFF LIST

1. Dr. E.N. Mwaura Dip Agric. Eng. (Egerton B.Sc. Agric. Eng. (Minnesota), M.Sc. Phd Agric. Eng. Michigan)
2. Dr. L.O. Gumbe B.Sc. Agric. Eng. (Nairobi) M.Sc Agric. Eng. (Cranfield), Ph.D Agric. Eng. (Ohio).
3. Mr. G. Muchiri B.Sc. (Israel), M.Sc. Iowa)
4. Mr. E.K. Biamah Dip. Agric. Eng. (Egerton) B.Sc., M.Sc. Agric. Eng. (Oklahoma)
5. Dr. F.N. Gichuki Dip. Agric. Eng. (Egerton), P.G. Dip. Irri. (BARI). B.Sc., Ph.D. Agric. Eng. (Utah)
6. Dr. P.G. Kaumbutho B.Sc. Agric. Eng. (Nairobi), M.Sc. Ph.D. Agric. Eng. (Michigan).
7. Dr. C.M. Maende B.Sc. Agric. Eng. (Nairobi), M.Sc. Ind. Eng. (Siera Leone). *Ph.D. Newcastle*
8. Mr. R.K. Muni B.Sc. Civil Eng. (Jadarpur), M.Sc. Agric. Eng. (Roorkee).
9. Mr. D.A. Mutuli B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (Newcastle)
10. Mr. L. Oudman M.Sc. (Wageningen).
11. Mr. V.K. Serem B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (McGill).
12. Mr. G.S.N. Mungai Dip. Agric. (Egerton) (Nairobi), P.G. Dip (Silsoe) *B.Sc, MSc Michigan state*
13. Mr. P.M.O. Owende B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (Nairobi).
14. Mr. J.O. Odhiambo Chief Technologist
15. Mr. F.M. Mutisya Dip. Agric. (Egerton)
16. Mr. F.N. Njogu Dip. Machinery, GI I and II
17. Mr. F.K. Wanguhu Electrical Part III, II and I (Kenya Polytechnic).

18. Mr. G.E. Chweya HND Agric. Eng. (Oxford), P.G. Dip. (Israel). AGT, II and I (Kenya Polytechnic).
19. Mr. D.N. Kabuthi MET II and I (Kenya Polytechnic).
20. Mr. G.E. Onyullo Dip. Agric. (JKUAT)
21. Mr. A. Karimi Part I and II (Kenya Polytechnic)
22. Mr. S.K. Ondieki Dip. Agric. Eng. (Egerton)
23. Mr. W.M. Wamutitu
24. Mr. Z. Gichiri
25. Mr. F. Wahome
26. Mr. M. Ayuya
27. Mr. B.N. Gatonye (Deceased)
28. Mr. J. Wamwiri (Deceased)
29. Mr. C.H. Odongo (Deceased)
30. Mr. G. Njuguna
31. Mr. S. Kamendi
32. Miss E.W. Mungai
33. Mr. D. Maina.

Annex IV List of Publications

USA/US
WB
WEKASP

United States of America
World Bank
Western Kenya Agricultural Support Programme

UNIVERSITY OF NAIROBI

DEPARTMENT OF AGRICULTURAL ENGINEERING

PUBLICATION LIST

DR. E.N. MWAURA:

Kijne, J.W., D.B. Thomas. de Meyere; E.N. Mwaura; and A.F. Fowler. 1985. Joint Review of the Department of Agricultural Engineering, University of Nairobi.

Munyiri, J.W.; E.N. Mwaura; and M.N. Opondo. 1987. Report on the visit to the International Trade Fair at Bucharest, Romania, 17th to 23rd October, 1987. Ministry of Foreign Affairs, Nairobi, Kenya.

Mwaura, E.N.; G. Muchiri, D.K. Some; J. Kahumbura; and P.K. Kimani. 1987. Report of the Agricultural Engineering Research Priority Formulation Task Force. KARI, Nairobi, Kenya.

Ackello-ogutu, C.A.; J.M. Bahemuka; and E.N. Mwaura. 1988. The Rural Structures Programme: A Critical Review. Ministry of Agriculture, Agricultural Engineering Division. The Rural Structures Unit, Nairobi, Kenya.

Marks, B.P.; D.E. Maier; E.N. Mwaura; and F.W. Bakker-Arkema. 1988. Optimization of the in-bin counterflow drying of corn. Paper No.88-6563. ASAE. St. Joseph, MI.

China, S.S.; E.N. Mwaura, D.K. Arap Some, J.N. Mugeto, J.N. Mutuura, and M.G. Nyambati. 1988. Rural oil seed processing in Kenya. Vegetable oil/protein System Programme, Working paper No.9 Egerton University, Njoro, Kenya.

Ackello-ogutu, C.A.; J.M. Bahemuka; and E.N. Mwaura. 1990. Reducing Post Harvest losses: Perception of farmers and extension workers in Kenya. Discovery and Innovation, Vol 2, No. 1 The African Academy of Sciences and the Third World Academy of Sciences.

Mwaura, E.N., R.G. Moreira, and F.W. Bakker- Arkema. 1993. Performance evaluation of drying of maize in an in-bin counterflow system using biomass energy. Agricultural Mechanization in Asia, Africa and Latin america. Vol. 24, No.1.

Nyaanga, D.M. L.O. Gumbe, and E.N. Mwaura. 1994. Temperature fluctuations in stored potatoes. Kenya Society of Agricultural Engineers conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Quantitative changes in some physical properties of potatoes during storage. Kenya Society of Agricultural Engineers conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Development of an equation for predicting temperature in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Mwaura, E.N. 199?. Prediction of thermal properties of cereal grains during drying (presented for publication in discovery and Innovation).

Mwithiga, G. and E.N. Mwaura. 199?. Thin layer drying equation for pyrethrum flowers (presented for publication in Discovery and Innovation).

DR. F.N. GICHUKI:

Books and Book Chapters

Gichuki F.N., Gachene C.K.K., Mungai D.N., Thomas D.B. and Biamah E.K. (In press).

Towards sustainable Land Use. Proceedings for the 4th National Land and Water Management Workshop held at Wida Motel in March 1993.

Tiffen M., Mortimore M and Gichuki F., 1994. More people, Less erosion: an Environmental Recovery in Kenya. John Wiley and Sons, UK.

Gichuki F.N. 1994. Soil Conservation. chapter II in Tiffen, Mortimore and Gichuki: More People Less Erosion: Environmental Recovery in Kenya. John Wiley and sons, UK.

Gichuki F.N. 1994. Water Conservation. Chapter 12 in Tiffen, Mortimore and Gichuki: More People Less Erosion: Environmental Recovery in Kenya. John Wiley and Sons, UK.

Hudson N., Cheatle R.J. Wood A. and Gichuki F.N. 1993. Working with Farmers For Better Land Husbandry. Intermediate Technology Publication in Association with WASWC. Exeter, UK.

Gichuki F.N. 1986. "An analysis of technical manpower needs and training activities in support of small scale irrigation development," Watering the Shamba, WMS II Report No.40, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Journal Articles

Biamah E.K., Gichuki F.N. and Kaumbutho P.G. 1993 Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27,105-12

Gichuki, F.N., Water W.R. and Merkley, G.P.: 1988. "Design and Operation Oriented Branching Canal Hydraulic Model: 1 Development" Paper submitted to ASCE, Irrigation and Drainage Division.

Gichuki, F.N., Walker W.R. and Merkley, G.P.: 1988. "Design and Operation Oriented Branching Canal Hydraulic Model II. Application," Paper submitted to ASCE, Irrigation and Drainage Division.

Merkley, G.P., Walker W.R. and Gichuki, F.N.: 1988. "Transient Hydraulic Modelling for Improved Canal System Operation," Paper submitted to ASCE, Irrigation and Drainage Division.

Allen R.G. and Gichuki F.N. 1988. Implication of Projected CO₂-induced climatic changes on irrigation water requirements in the Great Plains States, a paper submitted to ASCE, Irrigation and Drainage Division.

Gichuki F.N., Allen R.G. and C. Rosenwieg. 1988. Impacts of CO₂-induced changes in Irrigation water requirements in the Great Plains States, a paper submitted to ASCE, Irrigation and Drainage Division.

Technical Reports

Gichuki, F.N. 1994. Appropriate Water Approaches and Technologies Mortimore, M., Tiffen M. and Gichuki F.N. 1993. Sustainable Growth in Machakos. ILEIA Newsletter 4/93.

Gichuki F.N. 1992 Indigenous Land Husbandry Practices. A Review of Indigenous Land Husbandry Practices for Improved Soil and Moisture Conservation and Crop Yield for Environmental Conservation: a Kenyan Semi-arid Areas case Study. Overseas Division SRI Report OD/92/9.

Gichuki F.N., 1992 Environmental Change and Dry-land Management in Machakos District Kenya 1930-1990: Conservation Profile. ODI Working Paper No. 56. ODI, London.

Kiome, R.M. Gichuki F.N. and Willcocks T.J. 1994. Conservation of Water and Soil for Agriculture and Environmental Protection: Research Proposal for Kenya Project. Overseas Division SRI Report OD/94/15.

Tiffen M., Mortimore M and Gichuki F. 1994 Population Growth and Environmental Recovery: Policy Lessons from Kenya. IIED, Gatekeeper Series No.45.

Gichuki F.N. 1992. Agricultural Water Management Systems in Semi-arid and Arid Areas of Kenya, Department of Agricultural Engineering Report.

Gichuki F.N. 1992. Jua Kali Sprinklers Study, report submitted to Terra Nuoga.

Gichuki, F.N., Njuguna, S.G., and Muthuri, F. 1992 Drainage Impact Study, report submitted to Ministry of Agriculture, Irrigation and Drainage Branch.

Wangati F., Muchena, F., Gichuki F.N. and Sharma, T.C., 1992. Soil Erosion and Nutrient Loss Monitoring Programme, report submitted to Ministry of Agriculture, Soil and Water Conservation Branch

Gichuki, F.N. 1991 Drainage manual for smallholder drainage projects Willcocks T., Gichuki, F.N. and Mwanda C. 1991. Development of conservation tillage systems at EMI ASAL programme. Report submitted to EMI, Embu.

King, D.L. and Gichuki F.N.: 1988. Operation oriented canal simulation model, Water Operation and Maintenance, USDI, Bureau of Reclamation Bulletin No.145.

Gichuki F.N. 1988. Development of a branching canal network hydraulic model. WMS II Report No. 72, Development of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Gichuki, F.N. 1988. Users' manual for the USU main system hydraulic model. WMS II Report No.73, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Gichuki, F.N. 1988. Application of the USU hydraulic model. unpublished report submitted to the U.S Bureau of Reclamation, Operation Section, Denver.

Allen R.G. and gichuki F.N. 1988. Effects of projected CO₂-induced climatic changes on irrigation water requirements in the Great Plains States (Texas, Oklahoma, Kansas, and Nebraska), a report submitted to U.S. Environmental Protection Agency.

DR. KAUMBUTHO P.G.

Kaumbutho P.G., 1989. Using Bond Graphs in the Design of Dynamic Systems. Kenya Engineer; Journal of the Institution of Engineers of Kenya. Nov./Dec. 1989.

Biamah E.K., F.N. Gichuki and P.G. Kaumbutho. 1993. Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27 (1993) 105-123; Elsevier Science Publishers B.V. Amsterdam.

Owende P.M., P.G. Kaumbutho and J.N. Kamau. 1994. Mounted Implement for Sugarcane Stool Destruction. AMA Journal Agricultural Mechanization in Asia, Africa and Latin America. vol 25. No.2, 1994.

Awiti L.M., D.K. A. Some, P.G. Kaumbutho and L. Masimba, 1989. Sugar Production cost Study. Kenya Sugar Authority publication 1989.

Marennya, M.O. and P.G. Kaumbutho. 1993. Sugarcane Mill Yard Operations - The Development and Application of the "MSC-MYSM" Simulation Model. Paper presented to The International Conference of the Kenya Society of Agricultural Engineers, August, 3-6, 1993, University of Nairobi, Kenya.

Kaumbutho, P.G. and S.M. Makome, 1989. Safety as observed in selected environments of Kenyan manufacturing Industries. Paper presented to the management personnel of Kenya Breweries Ltd., General Motors (Kenya) Ltd., and B.A.T., (Kenya) Ltd., companies.

Marennya, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology.

Marennya, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in asia, Africa and Latin America (AMA)

Marennya M.O., P.G. Kaumbutho, C.M. Maende and J. Kamau 1993. An operational System Model for Sugarcane Mill Yard operations. Paper submitted to the African Journal of Science and Technology Series March 1993.

Gebresenbet G. and P.G. Kaumbutho, 1994. Comparative Analysis of the Field Performance of a Reversible animal-Drawn Ard-Mouldboard Plough and Conventional Mouldboard Ploughs. Paper presented for publication to the Journal of Soil and Tillage Research. July, 1994.

Marennya, M. P.G. Kaumbutho and J.N. Kamau. 1994. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operation. Discovery and Innovation. Journal of African Academy of Sciences. Box 14798, Nairobi. Kenya.

Kaumbutho P.G., L.M. Awiti and D.K. a. Some,, 1989. Survey of Cane and Sugar Production costs 1989. Kenya Sugar Authority.

Kaumbutho P.G., 1989. A Systems Approach to Technical Report Writing. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

Owende P.M., P.G. Kaumbutho and C.M. Maende. 1990. Comparing Methods of Sugarcane Stool Destruction. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o/ University of Nairobi Box 30197, Nairobi, Kenya.

Njau F. and P.G. Kaumbutho 1994. An Investigation on Noise Safety in Selected Environments of Kenyan Industries. Paper to be submitted to Safety Journal, USA.

Owende P.M. and P.G. Kaumbutho 1994. Machinery Testing as a Primer for Appropriate Agricultural Mechanization. Paper presented at the All Africa Engineers' Conference. Nairobi, December, 14-16, 1994

Kaumbutho P.G., E.G. Karuri and L.M. Awiti 1994. analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1994. Kenya Sugar Authority.

Mr. D.A. Mutuli.

Mutuli, D.A. (1988). "An Investigation into the effect of cultivator Design on seedbed preparation". Proceedings of the Annual Postgraduate Research Conference, University of Newcastle Upon Tyne, England.

Mutuli, D.A. (1992) "Advances in Agricultural Machinery Technology towards sustainable Development", proceedings of the KSAE Annual Seminar, 5-7th August.

Marennya, M.O., Kaumbutho, P.G. and Mutuli, D.A. (1993). "An operational systems Model for Cane yard operations". Paper accepted for publications in the ANSTI Journal (African Journal for Science and Technology).

Marennya, M.O. Kaumbutho, P.G. Mutuli, D.A. and Kamau, J.N. (1993) "Simulation of the Materials Handling System a Sugar Mill Yard case study", paper accepted for publication in the AMA Journal.

Shitanda, D., Mutuli, D.A. and Odongo, F. (1994). "Indigenous Vegetable Oils in Kenya as a Diesel Fuel". In Proceedings of the Kenya Society of Agricultural Engineers' 1994 International Conference august, Nairobi, Kenya.

Mutuli, D.A. (1994) "Agricultural Mechanization in Kenya: A Review of Policies and Strategies to date". In Proceedings of the Kenya Society of Agricultural Engineers (KSAE) International Conference August, Nairobi, Kenya.

Mutuli, D.A. (1994). "The Role of Agricultural Engineering in Food Manufacturing". In proceedings for the Kenya Institute of Food Science and Technology Conference, Nairobi, Kenya, November 7th - 9th.

Mutuli, D.A. (1994) "Some Engineering opportunities for the Sustainable Development of African Agriculture" Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Shitanda, D., Mutuli, D.A. and Odongo, E. (1994). "Renewable Energy Resources for Sustainable Development", The case for Diesel Fuel substitutes". Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Marenja, M.O., Mutuli, D.A. and Kaumbutho, P.G. (1994) "Simulating Sugarcane Mill Yard operations". Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Mutuli, D.A., Gumbe, L.O. and Sharma, T.C. (1994) "Review of the Drop/Check Structures Manual "Report of findings from a study carried out for the irrigation and Drainage Branch, Ministry of Agriculture, Livestock and Marketing, Government of Kenya, Nairobi.

Mutuli, D.A. et al (1994) "The GOM/ADF Malawi Agricultural Sector Study: A report of findings submitted to the Government of Malawi.

MR. MOSES O. MARENJA

Marenja, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology.

Marenja, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA)

Marenja, M.O. and P.G. Kaumbutho, 1993. Sugarcane Mill Yard Operations - the Development and Application of the "MSC-MYSM" Simulation Model. Paper written and presented to The International conference of the Kenya Society of Agricultural Engineers, August 3-6, 1993, University of Nairobi, Nairobi.

Marenja, M.O. and P.G. Kaumbutho 1993. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operations. Submitted to Discovery and Innovations. An African Academy of Sciences Journal.

Marenja, M.O. 1994. simulating Sugarcane Mill Yard Operations. Paper written and presented to The IEK/FAOE - All African Engineers' Conference on the Role of the Engineer in Sustainable Development, December 14-16, 1994, Kenyatta International Conference Centre, Nairobi, Kenya.

Marenja, M.O. and M.W. Kabeu, 1995. the Problems and Potentials of the Kenyan Sugar Industry. Paper written and presented to The International Conference of the Kenya Society of Agricultural Engineers, December, 15-16, 1995, Jomo Kenyatta University of Agriculture and Technology, Juja, Nairobi. (In Press).

CLEOPHAS M. MAENDE

O'Callaghan, J.R. (Editor); Maende, C.M.; and Wyseure, G.C.L. (1994): Modelling the intercropping of maize and beans in Kenya Computers and Electronics in Agriculture 11:351 - 365. Elsevier Science Publishers B.V. Amsterdam

Maende, C.M. (1994): An application of a model of maize growth to maize production by small holders in Kenya Ph.D thesis, University of Newcastle Upon Tyne, U.K.

Maende, C.M. (1995): Solar driven computational model of tropical maize. Proc. of 50th Anniversary Engineers' Conference of the Institution of Engineers of Kenya (IEK) and Engineers Registration Board (ERB). Kenyatta International Conference Centre, Nairobi, 22nd - 24th November.

BIAMAH, E.K.

Biamah, E.K., I.M. Nagaya, E.M. Gichangi and R.K.K. Cherogony (1994). Microscale effects of tillage and organic manure on infiltration and erosion of a crusting soil, In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K., R.M. Chiti and R.K.K. Cherogony (1994). Trends in infiltration runoff and soil loss of unstable crusting soils. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K. and R.K.K. Cherogony (1994). Tillage technique for effective soil erosion control in Kenya: Evaluation of alternative fanya juu terrace designs. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H. E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K., C.K.K. Gachene, P.T. Gicheru and R.K.K. Cherogony (1994). Crop response in tillage and residue mulching practices in a clay soil. In: Soil Tillage for Crop Production and Protection of the Environment. Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editor).

Biamah, E.K. C.K.K. Gachene, P.T. Gicheru and R.K.K. Cherogony (1994). Seasonal variability in soil moisture due to tillage and residue mulching of a clay soil. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K. and W.K. Yabann (1994). Training of Trainers Report on "Community participation in project planning in arid lands of Kenya." Emergency Drought Recovery Programme. Department of Relief and Rehabilitation, Office of the President, Kenya. October, 1994.

Biamah, E.K. and G.K. Maritim (1994). sectoral background profiles of arid and semi arid lands of Kenya. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. July, 1994.

Yabann, W.K., E.K. Biamah and A.J. Haji (1994). Report on "Environmental impact assessment of the Arid Lands Project (ALP), Kenya. Emergency Drought Recovery Programme. Department of Relief and Rehabilitation, Office of the President, Kenya. May, 1994

Biamah, E.K. G.K. Maritim and W.K. Yabann (1994). Report on "Grassroots Community mobilization in Kalokol, Central Turkana. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. May, 1994.

Biamah, E.K. J.K. Muketha and W.K. Sitonik (1994). Report of national seminar on "Community participation in project planning in ASAL areas of Kenya. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. February, 1994.

Biamah, E.K. and R.K.K. Cherogony (1993). Djabia rainwater harvesting system for domestic water supply in Lamu, Kenya. In: Proceedings of the 6th International Conference on Rainwater Catchment Systems held in Nairobi, Kenya August, 1993.

Biamah, E.K. (1992). "Production Oriented Conservation Strategy for developing sustainable projects in Arid and Semi Arid Areas of Kenya. In: People Protecting their Land Proceedings of the 7th International Conference on Soil and Water Conservation, Sydney, Australia, September, 1992.

Biamah, E.K., J.K. Gikonyo, P.T. Gicheru and S.O. Oketch (1992b). Influence of tillage on crop water use at Kalalu, Laikipia, Kenya. Accepted for publication by the East African Journal of Sciences, Kenya August, 1992.

Biamah, E.K., F.N. Gichuki and P.G. Kaumbutho (1992c). Tillage methods and soil and water conservation in Eastern Africa. Accepted by the Journal of soil Tillage Research, Elsevier Science Publishers. The Netherlands, September, 1992.

Biamah, E.K., (1991). Soil Erosion Survey of Kaibon Catchment, West Pokot District, Study funded through and Suam River Catchment Rehabilitation Project (SRCRP) of the Kerio Valley Development Authority (KVDA). Vidman Consulting Engineers. Nairobi

Thomas, D.B., and E.K. Biamah (1991). "Origin, Application and Design of the Fanya Juu Terrace." In: Development of Conservation Farming on Hillslopes. W.C. Moldenhauer, N.W. Hudson, T.C. Sheng and San Wei Lee (Eds). Soil and Water Conservation Society ankeny, Iowa, USA.

Biamah, E.K. (1989C). "Water harvesting and Conservation techniques for increased crop and fodder production in Arid and Semi Arid Areas of Kenya." Paper presented at a workshop on ASAL's soil and water conservation, Ministry of Agriculture, Nairobi, Kenya. September, 1989.

Biamah, E.K. (1989B). Editor of proceedings of a UNEP/FAO seminar on "Soil Conservation Strategy for Africa." Accra, Ghana. August, 1989.

Biamah, E.K. (1989a). "Training Requirements in Soil Conservation for African Countries." Paper presented at the African Network of Scientific and Technological Institutions (ANSTI) annual Meeting, University of Ibadan, Nigeria, August, 1989.

Biamah, E.K. (1988b). "Evaluation of Feasible Conservation Strategies in Sub-Saharan Africa: A case study on Kenya and Malawi." In: Challenges in Dryland Agriculture: A Global Perspective. P.W. Unger. T.V. Sneed W.R. Jordan and R. Jensen (Eds.). Proceedings of the International Conference on Dryland Farming, Bushland/Amarillo, Texas, USA. 15-19 August, 1988.

Smith, J.L.; Biamah, E.K.; Otieno, J.O. (1988). "Simulating Rainfall and Soil Erosion using a Distributed Parameter Model (ANSWER)" The Kenya Engineer,, Journal of the Institution of Engineers of Kenya. July/August, 1988.

Biamah, E.K. (1988a). "Environmental Degradation and Rehabilitation in Central Baringo, Kenya." In: Land Conservation for Future Generations S. Rimwanich (Ed). Proceedings of the 5th International Conference on Soil and Water Conservation, Bangkok, Thailand. January, 1988.

Biamah, E.K., (1987). "Lessons learnt from Arid and Semi Arid Lands Development Projects in Kenya." Paper presented at a Conference on Project Identification in Developing Countries, held at the University of Manchester, U.K. September, 1987.

Biamah, E.K.; (1986). "Technical and Socio-Economic considerations in rehabilitating and conserving an eroded/denuded catchment area: A case study of the Chemeron Catchment Area, Central Baringo, Kenya." In: Soil and Water Conservation in Kenya. Proceedings of the third National Workshop on Soil and Water Conservation in Kenya. D.B. Thomas, E.K. Biamah, A.M. Kilewe, L. Lundgren, and B.O. Mochoge (Eds). September, 1986.

Thomas, D.B.; E.K. Biamah; A.M. Kilewe; L. Lundgren and B.O. Mochoge, Eds. (1986). Soil and Water Conservation in Kenya. Proceedings of the Third National Workshop, Kabete, Nairobi, Kenya, September, 1986.

ACKNOWLEDGEMENTS

The review team would like to thank, firstly, the Royal Netherlands Embassy in Nairobi, which entrusted the team with the responsibility to execute this end of project review. The RNE has been completely open to discuss the successes and constraints encountered during the execution of the project when the team presented its de-briefing.

Similar frankness and forthrightness were met during all meetings and discussions that the review team had during the process of evaluation. Whether the persons involved in the discussions belonged to the Department at the University of Nairobi, to another University, to a Ministry, or to another donor organisation, they tried on the whole to provide the team with all the relevant information they possessed.

According to the review team, this implies that all those involved with the project are highly committed to it and put the importance of its success in the forefront. For this sincerity the team would like to thank all those who contributed their time and experience to the evaluation process.

Without the wholehearted collaboration of the staff of the Department, this review would hardly have been possible.

In the following, the report arrives at several conclusions and recommendations. These were developed during the evaluation process by the review team and have been tested and checked during subsequent discussions. This testing was done with staff involved in the project and with staff working in similar or closely related activities. Since many informants presented the team with personal opinions, it was decided that no specific names or functions of those who are in support of (part of) the contents of this report should be mentioned. This also implies that in the text no reference should be made to such support.

The review team wishes to state that, although in certain aspects disagreement was met, the conclusions and recommendations arrived at by the team were supported in general by the far majority of the informants and resource persons.

All conclusions and observations and possible mistakes are, nevertheless, the sole responsibility of the review team.

Biamah, E.K. (1986). "Environmental Degradation and Conservation within the Njemps Flats and Tugen Plateau Areas of Central Baringo, Kenya." December, 1986.

Biamah, E.K.; Nyagah, C.R.J.; (1985). "Proposed Integrated Rehabilitation Programme for the Chemeron Watershed Area, Central Baringo, Kenya," Project Proposal Document, Ministry of Agriculture, Nairobi, Kenya,

Biamah, E.K.; (1985). Editor, Proceedings of a Workshop on Soil Conservation on Grazing Lands, Ministry of Agriculture, Kenya.

Biamah, E.K. (1984). "Soil and Water Conservation in Kenya; Concepts and Practices" Unpublished Manuscript, Nairobi, Kenya.

Biamah, E.K. (1983). "Comparison between field measurements and local climatic estimates of crop water use in Oklahoma," M.Sc. Thesis. Oklahoma State University. Stillwater. Oklahoma, USA.

SHARMA, T.C.

Sharma, T.C., Mathare catchment runoff peaks prediction by IUH, African Journal of Science and Technology (under press) 1994.

Sharma, T.C. Stochastic features of drought in Kenya, Post Conference Proceedings (peer reviewed) of the International Conference Entitled "Stochastic and Statistical methods in Hydrology and Environmental Engineering", University of Waterloo, Waterloo, Ontario, Canada, June, 1993.

Sharma, T.C., Rainsum:a criterion for design of rainwater harvesting systems, Post-conference Proceedings (peer reviewed) of 6th International Conference on Rainwater Catchment Systems, Nairobi, Kenya, August, 1993, 419 - 427.

Sharma, T.C., A. Markov model of longest dry and wet spells and largest rainsums in Kenya, East Africa, Proceedings (under print), 50 Years of Water Engineering in South Africa University of Witwatersrand Johannesburg, South Africa, 14 - 15 July, 1994.

Sharma, T.C., A mathematical rainfall simulator, Proceedings of the annual seminar of Kenya Society of Agricultural Engineers, Kabete, Nairobi, August, 1990.

Sharma, T.C., A probabilistic study of drought duration in Kenya Proceedings of the Annual Seminar of Kenya Society of Agricultural Engineers, Jomo Kenyatta College of Agriculture and Technology, Nairobi, Kenya, August, 1991.

Sharma, T.C., Sediment rating curves revisited, Proceedings of the Annual seminar of Agricultural Engineers, Jomo Kenyatta College of Agriculture and Technology, Nairobi, Kenya, August, 1992.

Sharma, T.C., A Markov model for critical dry and wet days in Kibwezi, Kenya, Proceedings of the 4th National Workshop on Land and Water Management in Kenya, Nairobi, Kenya, February, 1993.

Sharma, T.C. Some conceptions about sediment rating equations, Proceedings of the 4th National Workshop on Land and Water Management in Kenya, February, 1993.

Sharma, T.C., ARMA Models for flow forecasting in African tropics, abstracted in Pre-conference Proceedings of the International Conferences entitled "Stochastic and Statistical Methods in Hydrology and Environmental Engineering", University of Waterloo, Waterloo, Ontario, Canada, June, 1993.

Sharma, T.C. Hydrology of rainwater catchment systems: an overview, Pre-conference Proceedings of 6th International Conference on Rainwater Catchment Systems, Nairobi, August, 1993.

Sharma, T.C. Potential of instantaneous unit hydrograph for runoff peak prediction in a Kenyan catchment, Proceedings of the 6th South African National Hydrology Symposium, Pietermaritzberg, South Africa, September, 1993.

Sharma, T.C., An application of drought severity analysis for water resources systems design, Proceedings of Institution of Engineers Kenya Seminar, Nairobi, Kenya, 23 - 25 March 1994, 14 - 20.

DR. L.O. GUMBER

Gumber, L.O. and Maina, B.M. (1989): "Elastoplastic constitutive parameters for Rice En-Masse", Kenya Journal of Science and Technology, Vol. 10.

Gumbe, L.O. (1989): "Physical Properties of Coffee": to be presented at the Summer Conference of the American Society of Agricultural Engineers, Quebec City, Canada, June 25 - 28.

Gumbe, L.O. (1989): "Mechanical Properties of Coffee", proceedings of the 11th International Congress on Agricultural Engineering, Dublin, Ireland, September 4-8.

Gumber, L.O. (1989): "Physical Properties of Grain Affecting Silo Pressures", proceedings of the 10th International Symposium on Agricultural Engineering, Beijing, China, September 12 - 15.

Gumbe, L.O. and Maina, C. (1988): "Friction Coefficient of Cereal Grains on Various Surfaces", Journal of AMA, Paper No. 869, Tokyo, Japan.

Gumbe, L.O. (1988): "Considering Material Behaviour in Silo Design". Kenya Engineer, March/April, 1988.

Gumbe, L.O. (1988): "Prediction Equations for Loads in Grain Silos", paper presented at NSAE/CIGR Symposium, September 4 - 10, Lorin Nigeria.

Gumbe, L.O. (1987): "Energy for Agriculture including Energy plantation: Special Case of Biogas Slurry System for Small-Scale Kenyan Farmers", paper presented at the Former DAAD Scholarship Holders Seminars, October 22 - 24, Nairobi, Kenya.

Gumber, L.O. and Muchiri, G. (1983): "Biogas Slurry Systems, Biogas for Rural Development, CSC Technical Publication No.137.

Gumber, L.O. (1983): "Appropriate Technology and Prospects in Grain Storage", Kenya Institute of Food Science and Technology Journal, Vol.1 No.3.

Gumber, L.O. (1983): "The BSc. Agricultural Engineering Course", Paper presented at the Agricultural Engineering Inter-University subject Meeting, September 5 - 10, Arusha, Tanzania.

GICHUKI MUCHIRI

Gichuki Muchiri (1979). "Development of Tillage and Equipment Systems in Kenya". Proceedings of Appropriate Tillage Workshop IAR Zaria, Nigeria. Common wealth Secretariat.

Gichuki Muchiri (1981). "Agricultural Machinery Production and Use in Kenya". Country Position Paper, UNIDO, VIENNA.

Gichuki Muchiri and Francis N. Gichuki (1982). "Conservation Tillage in Semi-Arid Kenya". Proceedings of a Second National Workshop on Soil and Water Conservation in Kenya. Institute of Development Studies occasional paper No. 42. Edited by D.B. Thomas and W.M. Senga.

Gichuki Muchiri (1984). "Farm Equipment Innovations for Small Holders in Semi-Arid Kenya". Chapter 3.0 in Farm Equipment Innovations in Eastern, Central and Southern Africa. Edited by Iftkhar Ahmed and Bill Kinsey. Gower.

Gichuki Muchiri (1985). "Development of Ox-drawn Equipment in Kenya". In "Excess Agricultural Machinery Manufacturing Capacity in Kenya." By Iftikhar Ahmed. Geneva Vienna.

Gichuki Muchiri, Timothy Simalenga, Nokwazi Moyo (1994). "Methodological Guidelines for Agricultural Mechanization Strategy Formulation". AGROTEC, Agricultural Operations Technology for Small Holder Farmers in East and Southern Africa.

Republic of Kenya, Ministry of Agriculture, Livestock Development and Marketing (1994). "National Agricultural Mechanization Strategy (NAMS) Formulation for Kenya". Final Report. Written: Mr. Gichuki Muchiri (Project Coordination), Mr. D.M.M. Mutiga, Dr. J.G. Kariuki and Mr. J.C. Boit.

publicat.lis/3.4.96.sm.

**Annex V Comments by the Academic Staff on
the Draft Report**

DEPARTMENT OF AGRICULTURAL ENGINEERING END OF THE PROJECT
REVIEW REPORT

Comments by Academic Staff

INTRODUCTION:

- 1.0 The twenty year project has been extended four times based on evaluation of each phase and strong recommendations by the evaluation teams.
- 2.0 The last three evaluations were bilateral and were conducted on the basis of an agreed terms of reference and membership of the team. It is instructive to note that the end of the project review was unilateral. The donor actually turned down suggestions for a more balanced disciplinary representation and deliberately rejected inclusion of an agricultural engineer.

- 3.0 The terms of reference for the current review focused on:

- achievement of short-term objectives
- achievement of long term objectives
- sustainability of the project.

The review team and academic staff concur on the short-term objectives namely:

- strengthening of teaching and research capacity of the Department of Agricultural Engineering.

They are also agreed that the short-term objectives were achieved satisfactorily by 1990 i.e. fifteen years from inception.

- 4.0 There is a major difference of opinion on the interpretation of the long term objectives and what might constitute their achievement. The statement contained in the terms of reference given to the review team states the long terms objective as follows:

- to create a development impact on Kenya's agriculture.

The evaluating team decided that the impact must be perceived at farm level and by the small-holder in particular. They went ahead and wrote a whole chapter 3.0 defining the criteria they would use to assess the impact namely:

- ability to diagnose problems, design and implement solutions with the farmer using the Farming Systems Approach to Development (F.S.D.).

This write up was backed up by a systematic methodology used in discussion, examination of research project reports and field interviews conducted.

5.0 Academic staff of the Department who implemented the project view the long-term objectives differently. To them the creation of development impact on the Kenyas agriculture at all levels, can be achieved indirectly and at best it can be only a small fraction in the National development effort involving several ministries, parastatals, and all the Departments in the four Kenyan Public Universities who have initiated programmes in Agriculture, Veterinary and Engineering. Moreover there is a very active private sector development including NGOs. If the team seriously wanted to know the small contribution from the project - an impossible task in ten days - they would have evaluated the agricultural sector as a whole and thus identify the main constraints to agricultural development and small-holder agriculture in particular. At the very least they would have read numerous reports by the Government, World Bank, FAO among others. They would have discovered that FSD is not yet a National strategy even in the Central Ministry of Agriculture, Livestock Development and Marketing. It is certainly not incorporated in the teaching of MSc or BSc in Agriculture or Diploma level in any of our Universities. Scientists are infact not yet agreed on its definition. However everybody agrees that it is a major discovery by socio-economists, albeit rather late, and in Kenya, KARI has been given the mandate to experiment with it and to incorporate it in the National Research Programme.

6.0 In our opinion it is unrealistic to expect BSc Agricultural Engineering Scheme of study to include farming systems content aimed at giving the undergraduate the capacity to diagnose problems at farm level, design solutions and implement them. If he did this he would be playing the role of:

- agricultural researcher
- agricultural extensionist as well as (his own)
- agricultural engineer.

7.0 In the four years currently available for BSc engineering training (the first year is used for preparatory courses) we are expected to turn out a graduate who can analyse a problem in its scientific context, design and specify details and procedures for implementation. It is left to the on job training for engineers to learn how to carry out a detailed project identification, design and implementation. A classical example of how this can be done and is infact being done is in the Ministry of Agriculture in Irrigation and Drainage project and Coffee Factory Engineering section of the Small-Holder Coffee Improvement Project.

Ironically the team had time to travel to South Nyanza - Homa Bay to meet farmers but on the way failed to see many engineering projects such as South West Kano Irrigation Scheme, Small rice rehabilitation project, small scale wheat and rice mechanisation and post-harvest projects.

They wanted to know whether we have reached the farmer through one of our smallest project namely: Draft Animal Power project (DAP).

- 8.0 One third of the core 47 pages of the draft report are devoted to DAP. This includes one chapter 3.0 which is meant to justify the criteria used to evaluate project impact. In chapter 4.0 specifically devoted to the discussion on achievements, 4 out of 9 pages are on DAP. Finally a full page 49 on recommendations is about DAP.

In contrast curriculum development which is the main function of the Department is covered in 1½ pages, 28 and 29 in chapter 2.0 and Department research thesis and publications are dealt with in one paragraph in chapter 4.0.

Without slighting the National and International importance of DAP in sub-sahara Africa it is fair to say that the project did not until recently attract staff or student research interest. The main cause for this emanate to the unscientific approach adopted by the initiators of the project who wanted to popularise the technology before doing research and development. Naturally there is very little impact. The project did not require the recommended Farming Systems Approach orientation for staff because farmers were heavily involved since they were already using the technology. What the Department should do (and has now 2 PhD candidates on the project) is to analyse the physical and biological factors that determine the draft power available and to improve equipment design.

Once the technology is specified fully including the design of harnesses and associated equipment, an extension package will be synthesised and should include:

- Engineering specifications and standards for the manufacture of equipment.
- training and extension software for farmers
- finance for the purchase of animals and equipment.

Unfortunately farmers cannot explain why the extension package has not come about. If the team had investigated the matter they would have found the right answers. But that would have been a misdirection of effort because DAP is only one of the energy sources that the department is concerned with, Others include: human power, biomass energy, solar, wind, and fossil fuels. The energy is applied to all the areas of agricultural engineering including:

- field operations and transport
- post harvest processing, preservation and storage
- soil conservation
- water harvesting and storage
- irrigation and drainage.

9.0 Other activities in the Department including research thesis and publications received little attention. This biased approach adopted by the team is a result of misconception as to what agricultural engineering is all about and what the long term impact of the department might be.

10.0 Although the team was given a report on the Departments efforts to revise the curriculum, no time was devoted to a discussion on the criteria the staff of the department, together with farmers and other users of agricultural engineering graduates, had developed over three days of brain storming. Paradoxically the team went ahead and suggested that about 60% of courses can be dropped to make way for farming systems orientation. The criteria used in arriving at this figure is not discussed. Moreover no experience in Africa or Asia has been quoted to verify the effectiveness of these proposals.

RECOMMENDATIONS:

11.0 The above observations by the academic staff suggest that although we agreed with the team on the long term contribution to the economy and to the agricultural sector in particular, there was a major difference of opinion with regard to the nature of our contribution and more so as to the actual functions of the department in making that national contribution. We therefore wish to make positive recommendations to the Netherlands Government on how the good project achievements can be sustained in the long term as we perceive our long term objectives.

12.0 A third party reading the report is likely to be influenced and mislead by several terminologies such as ivory tower, green revolution, high tech, high input, top-down, participatory, farmer oriented, which are not defined and sweeping statement such as (in chapter 3): 'the team will describe the developments and fundamental changes that took place in the thinking about agricultural production in East Africa; the transfer was made from high-tech, high input, and top down Green Revolution' thinking to a participatory, farmer oriented approach'. In chapter 3.0 the team admits that T and V which is the main strategy for agricultural extension in East Africa supported by World Bank, is top down and not farmer oriented, thus the thinking in Kenya and the World Bank may not have changed as suggested. On the other hand the team strongly states that the Department staff had not changed for the last twenty years while at the same time noting, as commendable, the recent Department effort to revise the curriculum in the right direction.

Recommendation. (i) To clear these differences and contradictions there is a need to have a truly bilateral evaluation exercise as soon as possible.

FUTURE ROLE:

- 13.0 The crucial issue is the future role of the Department as perceived by the staff and as to the nature of the enabling environment. The output of an end of the project evaluation must be to show clearly the way ahead not in ambiguous philosophical terms but in practical way that is not only understandable but realistic in the eyes of the implementor. (see recom. i)
- 14.0 The question of orientation of staff which the evaluators call managed change is important. In our view what is required is dialogue to create the necessary awareness. Externally managed change has serious implications which are better left out of this report (see recom. i).
- 15.0 Whatever good ideas that can come from the bilateral evaluation and ensuring staff orientation, nothing will be achieved and sustained unless basic budgetary provisions can be guaranteed. The team is right in concluding that GOK current budgetary provision are stretched to the limit. Extra cash has to come from income generating activities that the Department can create such as consultancy and inservice courses.

Recommendation (ii)

It is recommended that funds be raised to revitalise the Departmental Consultancy unit and in liaison with the College Entrepreneurial Committee look in ways and means of revitalising consultancy activities in a group instead of the current individualised approach.

- 16.0 Accepting positively the observation by the review team on lack of an integrated departmental research strategy, academic staff agreed:

- to review the national policies and strategies namely,
 - Agricultural Mechanisation
 - Irrigation and Drainage
 - Soil and Water conservation
 - Energy in agriculture

and thereafter extract what might be the Department Research role. With this background each staff member will identify his or her research interest. With the two inputs the department can harmonise National research goals with individual goals and thus define an integrated approach.

Recommendation (iii)

The Departmental staff will carry out the preliminary work suggested in 16 above and therefore plan a workshop to discuss its research policies and strategies for the future. Financial support for this exercise would be appreciated.

- 17.0 After looking into recommendations (i), (ii) and (iii) the capacity to implement a revised curriculum will be assessed. An immediate consideration will be how to carry out a major revision as agreed in the Department on this matter.

recommendation (iv)

It is recommended that the Netherlands government consider supporting a major curriculum review and revision exercise.

18. Sustainability of the Department functions and operations once clearly defined will depend on the attitude and morale of the staff who are expected to implement the programmes. In addition to the regular teaching and research the staff should develop a capacity to identify, design and implement a real world project which is bankable.

Recommendation (v)

There is a need to provide seed money to write a market oriented project proposal relevant to agricultural engineering and with a long term potential for income generation for the Department and staff.

REQUEST:

- 19.0 If the consultants wish to maintain their position and agrees with donor to circulate the review, we would humbly request that these comments be circulated with the report as an appendix.

PREAMBLE

Duration and timing

The team would like to observe that 10 days was a short time to review a programme that was of 20 years duration and involved over 100 person-years of research and teaching. Although December is a difficult period to get hold of people in Kenya, the team managed to get an adequate amount and variety of information. The team holds the opinion that information collected is correct and that the conclusions and recommendations were derived from proper facts.

Methodology

The methodology for this review was left to the team (see ToR in Annex I).

On the first day the team sat together and decided that the first two days would be used for interviews with staff at the Department of Agricultural Engineering. These two days all three team members attended the same interviews. This set-up provided all team members with the same basic information. On the third day, the occasion of the Annual International Conference of Agricultural Engineers at the Jomo Kenyatta University for Agriculture & Technology was profited from and JKUAT was paid a visit. The team split up to maximise the number of participants that could be interviewed. The next Saturday, the separate interviews were compared and analysed after which the outline for the report was established and certain tasks were divided. To evaluate better the impact of an activity (animal draft power) for which the Department had obtained an international reputation by the mid-1980s, Mr. Starkey went to visit contacts on this topic in Western Kenya during days 5, 6 and 7.

The two other team members after having written the first parts of the report on day 5, concentrated during days 6 and 7 on interviews with groups and organisations that can be qualified as users of the qualifications of the agricultural engineers. Interviews were held, e.g. with a major supplier of farm machinery Gailey & Roberts, with the Kiambu office of the NGO Plan International, with the Second Coffee Improvement Project (SCIP), and with the Ministry of Agriculture and Livestock Development, traditionally the employer of agricultural engineers.

The morning of day 8 was used by the team - by than together again - to brief one another and identify progress. At the same day, at the office of Sida at the Swedish Embassy, the SAREC contribution was discussed (besides the Netherlands support, the Department was and is supported by Swedish SAREC).

The morning of day 9 was used to prepare for the de-briefing to be given later that day. Contrary to previous missions, but in consultation with the Department and the Royal Netherlands Embassy, it was decided to do the de-briefing not only to the RNE but also and at the same occasion, to the staff of the Department.

The 10th day was used by the team to discuss the reactions to the de-briefing and for two members to prepare the materials that would be used for the writing of the final draft report. For these two the mission ended at that day. For the third member, the team leader, an additional five days were used to compile all information and materials into the final draft report.

To maximise on the specific knowledge of each of the team members, Mr. Bos concentrated on the wider context of the project, besides being the leader of the team. Mr. Mutiso focused on the institutional aspects, and Mr. Starkey on animal draft power and research aspects.

Dr. Kaumbutho

PUBLICATIONS

Undergraduate (Project) Thesis:

Design and Performance Test of a Chain Washer Irrigation Pump.

M.Sc. Thesis:

Development and Performance Test of a Three Point Hitch Dynamometer for Tillage Energy Research.

Ph.D. Dissertation:

A Bond Graph Model for Simulating the Performance of a Farm Tractor.

Kaumbutho P.G., R.C. Rosenberg, T.H. Burkhardt and A. K. Srivastava. 1987. Tractor Performance Simulation Model Using Bond Graphs. Paper No. 87 - 1503, American Society of Agricultural Engineers, St. Joseph, MI. 49085 - 9659. USA.

Kaumbutho P.G., 1989. Using Bond Graphs in the Design of Dynamic Systems. Kenya Engineer; Journal of the Institution of Engineers of Kenya. Nov/Dec. 1989.

✓ Biamah E.K., F.N. Gichuki and P.G. Kaumbutho. 1993. Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27 (1993) 105-123; Elsevier Science Publishers B.V. Amsterdam.

✓ Owende P. M., P.G. Kaumbutho and J.N. Kamau. 1994. Mounted Implement for Sugarcane Stool Destruction. AMA Journal Agricultural Mechanization in Asia, Africa and Latin America. Vol 25. No.2, 1994.

Awiti L.M., D.K. a. Some, P.G. Kaumbutho and L. Masimba, 1989. Sugar Production Cost Study. Kenya Sugar Authority publication 1989.

P.G. KAUMBUTHO

- X Kaumbutho P.G., S.M. Ithula. 1990. The Status of Agricultural Mechanization in Kenya - Now and into the Future. Proceedings of the 2nd Symposium on Science and Technology, September 11-13, 1990. Research Council of Zimbabwe, Scientific Liaison Office, P.O. Box 8510, Causeway. Zimbabwe.
- X Kaumbutho P.G., D.K.a Some and L.M. Awiti. 1990. Analysis of Sugarcane and Sugar Production Costs. November, 1990. Kenya Sugar Authority.
- X Kaumbutho P.G., 1991. Principles of Costing of Operations of Land Preparation, Cultivation and Sugarcane Transport. Lecture paper presented at the Workshop on Sugar Production Costs under the auspices of the Kenya Society of Sugarcane Technologists. Kisumu, Kenya.
- ✓ Owende P.M., P.G. Kaumbutho, C.M. Maende and J.N. Kamau. Comparison of Options for Sugarcane (*Saccharum Officinarum* L.) Stool Destruction. Paper accepted for Publication by the *Soil and Tillage Research Journal*. December 1994. *Published*
- X Kaumbutho P.G., 1991. Efficiency Considerations in the Performance of the Sugar Industry. Lecture paper presented at the Workshop on Sugar Production Costs under the auspices of the Kenya Society of Sugarcane Technologists. Kisumu, Kenya.
- X Kaumbutho P.G., D.K.a Some and L.M. Awiti. 1991. Analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1991. Kenya Sugar Authority.
- ✓ Kaumbutho P.G., 1992. Options for Agricultural Mechanization of Sugarcane Production and Transport Operations. Proceedings of the Workshop on the National Mechanization Strategy (NAMS). February 26-28, 1992. Ministry of Agriculture, Agricultural Engineering Division. P.O. Box 30028, Nairobi, Kenya.
- ✓ Kaumbutho P.G. 1992 Options for Agricultural Mechanization of Sugarcane Production and Transport Operations. Proceedings of the Workshop on National Agricultural Mechanization Strategies for Kenya. Masinga February 1992.
- ✓ Awiti L.M., Kaumbutho P.G. and D.K.a Some. 1992. Analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1992. Kenya Sugar Authority.
- X Kaumbutho P.G. and G. Mwago. 1993. Feasibility Evaluation of Alternative Agricultural Mechanization Options for the Production of Sugarcane, Rice and Wheat in Kenya. Ministry of Agriculture, Agricultural Engineering Division. May, 1993.
- ✓ Kaumbutho P.G., Awiti L.M. and E.G. Karuri 1993. Analysis of Sugarcane and Sugar Production Costs: The Liberalized Kenyan Sugar Market. December, 1993. Kenya Sugar Authority.

P.G. KAUMBUTHO

✓ Marenya, M. O. and P. G. Kaumbutho. 1993. Sugarcane Mill Yard Operations - The Development and Application of the "MSC-MYSM" Simulation Model. Paper presented to The International Conference of the Kenya Society of Agricultural Engineers, August 3 - 6, 1993, University of Nairobi, Kenya.

Kaumbutho, P.G., and S.M. Makome, 1989. Safety as observed in selected environments of Kenyan manufacturing Industries. Paper presented to the management personnel of Kenya Breweries Ltd., General Motors (Kenya) Ltd., and B.A.T., (Kenya) Ltd. companies.

✓ Marenya, M. O., P. G. Kaumbutho, D. A. Mutuli and J. N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology. *(Pending - believe it or not!)*

✓ Marenya, M. O., P. G. Kaumbutho, D. A. Mutuli and J. N. Kamau. 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA). *Published*

✓ Marenya M.O., P.G. Kaumbutho, C.M. Maende and J. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Paper Submitted to the African Journal of Science and Technology Series March 1993.

✓ Gebresenbet G. and P.G. Kaumbutho. 1994. Comparative Analysis of the Field Performance of a Reversible Animal-Drawn Ard-Mouldboard Plough and Conventional Mouldboard Ploughs. Paper presented for publication to the Journal of Soil and Tillage Research. July, 1994. *Revised for Publication*

✓ Marenya, M. P.G. Kaumbutho and J.N.Kamau. 1994. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operation. Discovery and Innovation. Journal of African Academy of Sciences. Box 14798, Nairobi. Kenya.

Kaumbutho P.G., L.M. Awiti and D.K. a. Some, 1989. Survey of Cane and Sugar Production Costs 1989. Kenya Sugar Authority.

Kaumbutho P. G., 1989. A Systems Approach to Technical Report Writing. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

Owende P.M., P.G. Kaumbutho and C.M. Maende. 1990. Comparing Methods of Sugarcane Stool Destruction. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

✓ Njau F. and P.G. Kaumbutho 1994. An Investigation on Noise Safety in Selected Environments of Kenyan Industries. Paper to be submitted to Safety Journal, USA. *Not yet*

- Similar paper published 1995 in Soil & Tillage Research

- Another in AMA (different content) in AMA

Mwaura, E.N., R.G. Moreira, and F.W. Bakker-Arkema. 1993. Performance evaluation of drying of maize in an in-bin counterflow system using biomass energy. *Agricultural Mechanization in Asia, Africa and Latin America*. Vol. 24, No. 1.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Temperature fluctuations in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Quantitative changes in some physical properties of potatoes during storage. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Development of an equation for predicting temperature in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Mwaura, E.N. 199?. Prediction of thermal properties of cereal grains during drying (presented for publication in *Discovery and Innovation*).

Mwithiga, G. and E.N. Mwaura. 199?. Thin layer drying equation for pyrethrum flowers (presented for publication in *Discovery and Innovation*).

July, 1995.

0 EXECUTIVE SUMMARY

By the middle of the 1970s, the Netherlands Government provided an extensive input in the irrigation sector in Kenya, including a considerable input in expatriate personnel. To see to sufficient and qualified counterparts, a project for support to the Department of Agricultural Engineering was committed. This project ended by 1 January 1996, after 20 years of continued support by the Netherlands Government.

The short-term objective seems to be achieved. A well-trained staff of about 15 lecturers exists, mostly PhDs. Close to 400 students enrolled at the Department and 375 graduated, and adequate facilities like class-rooms, offices and laboratories are in place. Equipment provided under the project, in principle, is sufficient. Strategic thinking at the Department has hardly concentrated at solving the problem of future sustainability while the GoK input in the University system is inadequate for survival and will continue to decrease. The last phase (out) of the project was intended by the donor to prepare the Department for 1996 and thereafter, but basically the only serious solution considered is to secure another donor (or 'horse') to survive.

At the time the project started, the global thinking was that the need for improved agricultural production would be satisfied through the development of better inputs like new varieties, fertilisers, etc. All these improved inputs would be generated at research stations and at Universities and disseminated through national extension systems. In line with this 'green revolution' thinking was the assumption that smallholder production was primitive and old-fashioned, and that it would soon give way to efficient, modern, specialised large-scale production using tractors and combine harvesters.

This thinking deeply affected the way national agricultural research was organised with a commodity and factor orientation, and the way extension systems were supposed to function as a deliverer of a ready-to-use package. Where technologies are concerned, the focus was on mechanised farm power, large scale storage, etc.

By the middle of the 1980s it became more and more accepted at formal national and international levels that in sub-Saharan Africa this approach had failed and that a different approach had to be organised. Agricultural research in the region is now gradually switching to a farming systems approach, and extension is looking for more unified and participatory methods and systems. A general observation made by those involved in such transition processes is, that especially the way research and extension staff have been trained and educated, represents a serious constraint.

It generally has been accepted by now that smallholder production is and will be the mainstay in the region.

Agricultural engineering, traditionally seen as an engineering topic, has not yet made any significant changes in its thinking. The Department of Agricultural Engineering at the UON still operates along the same premises that were in force 20 years ago and has not been affected by the mainstream of conceptual development in agricultural production in the region. Thus, where - at a first glance - the short-term objectives of institution and capacity building have been achieved by the project, the long-term objective to improve agricultural production of smallholders, has not been met. Training and research at the Department have very little to do with the existing smallholder production system in the region.

The staff at the Department is predominantly trained at Universities in mid-western USA, at universities that were purposely established to support that large-scale, mechanised production system. Little wonder that most feel disoriented when coming back as PhDs after six or more years when they are faced with the reality of Kenya's smallholders.

A specific example that supports the above conclusions is provided by the Animal Draft Power project, for which the Department had international fame in the 1980s. Typically, this ADP developed a technology at the University and tried to disseminate the "perfected" product to the farmers. Now, 10 years later, the adoption rate is negligible.

A research strategy is missing, despite strong recommendations in earlier review reports.

The analysis of the subjects the students used for their MSc theses illustrates the focus on the large scale, commercial sector and the unawareness of the smallholder production that generates over 80 % of the agricultural produce in Kenya.

Yet, some indications exist (a few attempts were made to arrive at strategic plans, etc.) that with the proper management, it might be possible to re-orient (part of) the Department towards the smallholder production sector and amalgamate the now highly divided Department. Such a change - probably to be managed from the outside - should include training of the staff in socio-economic aspects of smallholder production, in participatory techniques, and in involvement with FS teams. Changes in the existing curriculum should achieve the same for future students and prepare them better for the market. Now the far majority of the graduates is facing unemployment.

To make the Department more able to become self-sustainable, staff should be trained in entrepreneurial / consultancy skills. The fact that quite a number of the staff already spends a considerable amount of their time on private consultancies could be profited from.

For this managed change, external support (donor) is required. The chances of success are unclear but can be looked into in more detail.

The Netherlands Government decided that Phase IV would represent a phasing out and that 20 years of support should be sufficient. Yet, a number of reasons can be given to reconsider such a decision, the most important one being that the Netherlands Government is largely involved in the changes in agricultural research that are taking place and is preparing a substantial programme in Western Kenya of which unified extension is a central element. It could make sense not to neglect the third side of the triangle and continue to pay attention to the education part. Agricultural engineering has a role to play in the new participatory approaches since technology development lagged behind.

As stated above, the changes for success are difficult to assess by this team, but a possible collaboration with Sida / SAREC that supports the Soil & Water section of the Department might be possible. The team was informed that Sida is serious in re-orienting this section while it cannot pay attention to the two other sections of Farm Power and Machinery and Processing and Structures.

It was also observed by the review team that technology development for smallholders has an important gender aspect. Quite a number of smallholder technologies determine and dominate especially the life of the female farmers, and improvements will particularly better their situation. Since smallholder technology development is so intimately linked to women, it is noteworthy that only very few female students have enrolled and that the staff composition of the Department is fully male.

The proposed re-orientation and especially a modified curriculum could make the Department more accessible to female students.

6 SUSTAINABILITY

6.1 GoK

The funds supplied by the GoK have always been insufficient to run a Department of this size and this is not likely to improve. Besides the lack of operational funds, funding for the maintenance of buildings and equipment is, at the moment, totally inadequate. Even bleaker is the picture for (the replacement of) equipment and other assets of the Department, since depreciation is a vote unknown in the budgetary system.

At present, three Universities are equipped with a Department of agricultural engineering. The number of students graduating and lecturers employed is far too high compared with the demand side. Also this fact of over-capacity makes it improbable that GoK will ever be able to adequately finance this or any other Department of agricultural engineering.

The Department can partly survive with the support provided by SAREC (now merged into Sida) during 1996 and 1997, although earmarked for the Soil and Water section of the Department. However, if donor dependency persists while the GoK cannot deliver, the Department will, after 1997, rapidly decay and disintegrate.

To a certain degree, the Department is already disintegrating. The fact that the GoK blocked (after a one-year strike) the formation of a Union, strongly de motivated the staff putting into danger the future existence. The overall loyalty of the staff demonstrated by coming back after graduating abroad, has now given way to an overall little commitment for the Department and a very individual attitude for survival.

Although informed by the Chairman in advance, most of the lecturers were not available to the review team, and the debriefing was attended by six Kenyan staff members only.

6.2 Lecturers

The lack of motivation combined with the economic reality that, especially since 1993, the salaries are insufficient to survive, created the situation that most of the lecturers are hardly present at the Department, except for the hours that they are teaching. Several of them are registered as a private consulting company and work as such. It is not exaggerated to state that the main occupation of the staff is consultancies (this could open opportunities for the future though).

Apparently this survival approach has been accepted by the management. Even stronger, as indicated earlier, the required change in the curriculum of the Department was refused to be executed by the staff unless they get paid for it, and this principle of getting paid for such tasks has been excepted by the management of the Faculty (although the funds are not available and no change will be effectuated).

6.3 Future

No substantial or departmental vision related to the future exists other than the hope for a new donor and the attempt to also 'open' the Soil and Water section (supported by Sida / SAREC) to lecturers in the two other sections of "Farm Power & Machinery" and "Processing & Storage".

By consequence, no strategic plan incl. curriculum, research/extension, intake, etc. exists, as explained earlier.

On an individual basis, some of the lecturers have some ideas related to income generating activities but all put together, these are by far insufficient to rescue the Department as it is now.

Yet, generation of income is in principle possible according to the parastatal status of the University.

7 CONCLUSION AND RECOMMENDATIONS

7.1 The concept of the project

It can be concluded that the project 'missed' the important developments in the thinking about agricultural production in sub-Saharan Africa or Eastern Africa for that matter, especially during the 1990s. Neither the Department, nor the expatriate staff or the donor observed or acted upon this. What was the common thinking at the start of the project is no longer in force.

- In order to better serve the purpose of sustainable agriculture the Department should develop a smallholder farmer oriented approach (see § 7.2 for details).

The review team feels supported in this key recommendation by J.G. Speth, the Administrator of UNDP by 1993. In the Sir John Crawford Memorial Lecture he gave on 25 October 1993 to the Consultative Group on International Agricultural Research (CGIAR), he stated (page 5 of the transcript):

"Our development work must also include real participation of and ownership by the beneficiaries of development. Top-down development is out. Development can be achieved only where people have an opportunity to participate in the events and processes that shape their lives;"

And:

"You [...] have demonstrated your abilities to carry your research into farmers' fields through your extensive farming systems research efforts. As you plan and implement eco-regional and other research programmes, the participatory process must be strengthened. Small farmers and local organisations must be involved from the identification of problems and the first planning exercises. They must become co-owners of the research by clearly identifying their needs, by relating their past experiences and indigenous knowledge in meeting these needs, and by participating in the research process."

7.2 Achievements

7.2.1 Curriculum

The project has from the beginning focused on assuring that it produced teaching staff cloned from the international definition of an Agricultural Engineer. This product was to produce a curriculum again accepted by his peers internationally. These are two clear successes. However, the produced staff did not have the orientation towards the smallholder problems, for the training system they took part in was not so oriented.

The project on its part did not insist on this criterion although it is found in the documents. Consequently the curriculum has little practical farmer oriented, bottom up content. The outputs of the curriculum at the graduate level end up in supervisory levels with limited farmer contact. The BSc level outputs, according to limited interviews, end up learning about farmers on the job.

They pick up socio-economic analytical skills on the job. Given the staff training, especially the concentration on the advanced technological systems in US universities, their interest is in those technological large scale activities, which lend themselves to technological solutions is not surprising. Their contribution, for example, to coffee

processing, pyrethrum drying, maize storage and estate sugar production has been significant precisely for that reason.

TRANSCRIPT OF AN INTERVIEW

CASE ONE

I was born in _____ among the pastoralists. When I came to the university I wanted to do agricultural engineering so that I could help my people solve some of the animal watering problems. I did not get much along these lines. The only time animals were mentioned was in the courses on Farm Management and Extension. Farm management and extension apply to the high rainfall areas and they really are not of much use to pastoralists. I always wonder why the curriculum ignores the problems of the dry areas that are the sources of meat nationally. There are very few slaughter animals in the high potential areas.....Of course it is true we touched on animals in the Farm Structures course when we were designing zero grazing houses. We also took part in some demonstrations of ploughing by animals.....

I graduated with a BSc in 1990. After graduation I went to work for National Irrigation Board scheme in _____. I think we should have started to specialise by the second year. This way perhaps we could have learned more about irrigation and drainage..... Nobody taught me how to handle farmers, especially the old people. Although I like the work, the scheme has many problems teaching farmers. We want to introduce other crops. We have had to meet with farmers to discuss this programme.....We got general lectures on extension. This was not specific for irrigation. We are learning in the field how to work with farmers. My colleagues are the ones who teach me about economic and social analysis for they have been in the field longer than me. The curriculum should have included dealing with officials and farmers.....

I would like to go back to university. I have applied for a scholarship. I want to study more.

The strong conclusion then is that the Department has not seen fit to include matters of smallholder production as a central focus in its training. Second, there are too many theoretical courses, especially at the BSc Level. This fact is recognised in the Department but attempts to revise the BSc curriculum are bogged down in the personalised departmental decision-making style that has seen faculty members fight over the revisions for the past two years.

It is the opinion of this mission that the Department should build on the inconclusive discussions about the strategic plan and curriculum revision. A donor can facilitate this by offering a consultant with organisational development skills ('manager of change') to help the Department go through team building process to develop these very key documents for its survival. The procedure should be as follows: all staff members should be required to prepare proposals for circulation to all other staff members. After an interval of study individually, these should be discussed within the sections so that the sections can agree on section priorities. Again, these should be circulated to all staff members and sufficient time allowed for individual study. Finally the Research and

Education committees should prepare a document before calling the whole Department to a retreat to complete departmental proposals. These should be circulated to all staff members and sufficient time given for study. The Department should then meet to discuss what to adopt.

Such a process in Team Building, assisted and facilitated by an external organisational development practitioner ('manager of change'), ought to affirm to the Department their own confidence for part of the lack of tolerance and co-ordination is partly failure to rise to the common good because of lack of confidence in the institution.

- There are too many courses. Perhaps a reduction by about 60% will be in order.
- There clearly is need for a re-orientation; to increase courses on economics and sociology for agricultural engineering takes place in society.
- During this reduction and reconstitution of the curriculum contents, there should be planned systematic practicals with participatory techniques in the time saved. Such practicals should recognise the centrality of smallholder production in the national economy. The recommendation simply means that all curricula should have more extensive time devoted to practical activities in teaching and research in the field. Such activities should be spread through all Kenyan farming systems with special attention to smallholder production systems that accounts for more than 80 % of the total national agricultural production.
- If training abroad cannot be avoided, practical field work to be done in Kenya through sandwich formulae
- Lecturers and students are to be trained in PRA and PTD techniques.
- Also the graduated ones are to be trained if possible, e.g. through the establishment of an Alumni Association through seminars workshops and participation in (KARI) FS teams.
- Instead of a(n) expatriate lecturer(s) that has no other added value than to complement lecturing capacity and watch the money, assign a 'manager of change' for one or two years to take care of the re-orientation.
- Networking is to be supported (important as future channel for FS based experiments and training experiences).

7.2.2 Research, theses and other publications

general

In conclusion it appears that, while individual staff members are clearly capable of undertaking research in a conducive environment with clear leadership, such conditions have yet to be created within the Department.

- The 'manager of change' c(sh)ould also be instrumental in this respect.
- A strategic research plan has the utmost priority and should be developed keeping in mind the relevance for the smallholder production sector. It would mean that the deliberate choice has to be made that the relevance for the societal needs will have to prevail over the 'academic freedom'.
- This should also imply that the topics selected for theses by students will have to fit the same strategic framework.
- More bottom-up/farming systems should form the basis (synergy with Dutch support to research and extension) for new applied research projects.
- Link research / field work to existing GoK programmes in e.g. KARI.
- Re-orient identification of research projects and finish the ones now accepted.

It must be underlined that the focus on the predominant needs of the agricultural production sector in Kenya at the cost of the academic freedom, in no way implies that the standard or level of the research will (have to) go down.

Specific Animal Draft Power

Work relating to harnessing (and other animal draft technologies) in the Department started with much enthusiasm, but relatively little objectivity. Modest attempts at promotion based on non-participatory methods have continued almost unchanged since that time. The Department does not appear to have evaluated the technology rigorously nor has it analysed its own experiences critically. It does not appear to have kept abreast of current literature relating to either harnessing technologies or to extension methodologies. In short, it has not made use of its acquired national and international reputation and its available expertise and contacts to provide professional leadership in this field. It is not too late for it to do so, and the recent formation of KENDAT, affiliated to ATNESA, has provided new ideas and impetus that could lead to a rapid improvement in the situation.

- Animal Draft Power should remain an important component of the Department's research, teaching and out-reach programmes.
- However the topic could benefit from both a participatory approach and national / international networking collaboration.
- Department staff, in co-operation with KENDAT and colleagues from Egerton, JKUAT and KARI, should critically review the present status of animal draft technology in Kenya, collating existing information and identifying priority areas for participatory research-extension and teaching/training requirements.
- Current thinking in animal traction research, extension and training should be included as topics in the proposed "reorientation" exercise within the Department.
- The experiences of the Department in harnessing be critically reviewed and analysed and published as a valuable case history for the region (perhaps in collaboration with ATNESA and / or KENDAT). This would also be a valuable teaching aid.
- The Department should undertake a review of harnessing systems and select a range of options for donkeys for participatory testing with farmers / transporters in the vicinity of Nairobi, with economic acceptability being a key criterion for success. This work could be carried out in association with KENDAT and / or interested NGOs. This could also provide valuable lessons for students.
- If a member of staff or student were interested, running parallel to the other harnessing work, a series of objective, replicated trials on harnessing might be carried out using data-logging instrumentation techniques. Prior to any such research, a thorough review of previous trials world-wide should be made, and contacts be made with researchers at the Universities of Edinburgh, Hohenheim and Cornell who have implemented comparable trials (contacts available through ATNESA / KENDAT).
- Those responsible for implementing the Animal Draft Power Project in Homa Bay, should be given a chance to learn about the participatory methods employed by projects and organisations, e.g. those described earlier in § 4.4.

topics for theses

The small number of theses' topics that is relevant for the smallholder production and, thus for the fulfilment of the long-term objective leads to the conclusion that a research strategy and priority setting are urgently required.

- The recommendation made in this respect in earlier reviews and earlier in this review, is repeated and underlined.

7.3 Institutional aspects

7.3.1 Employment

After 20 years of implementing this project, this mission finds it remarkable that nobody has any quantitative data on the national demand for agricultural engineers. Nobody seems to have any quantitative data on utilisation of the supply since the beginning of the project. Two other universities have started programmes in agricultural engineering without establishing demand and specifying what training levels were needed. Such specification would assist in settling some of the institutional problems specified above.

Second, we have evidence from interviews that graduates are beginning to have problems getting jobs. Although not stated, it appears the project assumption was that most graduates will be employed by the Ministry of Agriculture. Given the dictates of Structural Adjustment, this is no longer possible and we project that many graduates, like their other professional colleagues, the Veterinarians, will increasingly not get jobs in the public sector. From this, the obvious conclusion is that Agricultural Engineers are being trained for self employment or employment in the private sector.

TRANSCRIPT OF AN INTERVIEW

CASE 2

I finished the BSc in 1988. I wanted to work for a multinational, for the pay and work conditions are good. Therefore when _____ advertised I applied and was employed. They are part of Unilever..... The training gave me a broad perspective. I was able to pick up on the products we sell. The basic engineering was good. _____ cut down on training us for we are engineering literate. We understood pumps, engines and irrigation. All three of us who graduated the same year are employed as salesmen. We do not do any design or fabrication work for our company brings everything almost ready. Whatever has to be assembled is done by technicians and mechanics.The three of us have not sought registration as engineers by the Engineers Registration Board. We do not need it. Our promotion is dependent on how we do in the internal training programme that is one of the best in the world. I have not stayed in contact with the Department. In the back of my mind I have always thought of going back to school for an MBA in marketing. The problem is sponsorship.

None of us are members of the Association of Agricultural Engineers. We have tried to assist it by internally speaking to the top managers to give it sponsorship.....Other than the three of us here, I know about five other classmates. _____ is an academic at the university. _____ worked for the Ministry of Agriculture and now is a consultant on coffee factories. _____ was working for a small business development organisation since we left the university but next month he will be working as a salesman for _____, which is a multinational selling equipment. _____ is working for a tyre company in sales. _____ is farming

The mission believes that the problem of tracking graduates, both BSc and MSc, has now become extremely urgent.

- Tracking is needed to establish which components of the Department are marketable and how much engineering or agriculture is needed in the products.
- Over and above a detailed tracking study, there is need for a national agricultural engineering personnel demand study.

Both studies should be done immediately and should cover the three universities producing agricultural engineers and preferably of total samples for they are estimated to be less than 500.

- Depending on the conclusions of these two studies critical decisions need to be made about the institutional set up of training.

7.3.2 Faculty of Engineering or Agriculture

The mission is of the view that, to fulfil long term needs of smallholders, there is a more likely chance of focusing the training on them if the Agricultural Engineering Department is academically in the Faculty of Agriculture.

- Transporting students to take courses in the centre of Nairobi is not sustainable. Why is it that the students are not housed in the main campus when they need to be trained in the Faculty of Engineering to cut out transportation? Can scheduling of courses be changed to facilitate this?
- The mission is of the opinion that the Department and all other Universities offering agricultural engineering should make presentations to the Engineers Registration Board to accept their being housed in Faculty of Agriculture.
- If this is not acceptable, they should make representations to the state for independent registration of Agricultural Engineers under a board which does not include other engineers.
- Some of the professionals in other universities argue that there should be specialisation of the three universities. This should be explored now if it leads to reduced operating costs and relevance.
- Presentations should be made to the government, other donors financing the Department, and the Netherlands, to finance the equipment to facilitate locating all training on the Kabete Campus under the Faculty of Agriculture, for transporting the increasing numbers will not be sustainable.

7.4 Sustainability

It must be concluded that the result of 20 years support is neither adequate to serve the actual demands in agricultural production, nor is it very sustainable. For the latter, the project cannot be blamed exclusively, also (f)actors beyond control of the project or donor or Department played an important role, like the ever reducing GoK contributions, the University strike, etc.

There seems no reason to expect that the GoK can change its financial policy towards the Universities, and the search for another 'horse' (donor) to switch to will only push the problem of sustainability forward.

The fact that several lecturers are already actively engaged in consultancies might provide the solution. It seems the obvious and only way to go for the Department. The *conditio sine qua non* is that the individual approach is left behind and that the staff starts operating as a team: as a professional consultancy group; an internal matter. Team holds the opinion that skills building is an important aspect of such a process and should be part of the overall re-orientation.

- A serious effort is to be given to re-orient the capabilities of the staff.

- Training of the lecturers in consultancy skills (acquisition, proposal writing, budgeting, etc.) might greatly assist the sustainability.
- Training in entrepreneurial skills is important in this (to be combined with the manager of change mentioned earlier).
- The establishment of a package of short courses to be given by the staff has potential for the generation of income. A renowned institute like the IAC / Wageningen could be of assistance to build this up.

7.5 Synthesis of recommendations and conclusions

Most of the recommendations refer to the Department; those will not be synthesised. The team tried to make it clear that basically these are the most important recommendations that have to be picked up by the staff of the Department: a change in attitude is required if the Department wants to survive. In general, all recommendations relate to such a change.

In case the staff is prepared to do so, it might be worthwhile to consider outside support: external financial support and external management support for re-orientation. This final part briefly summarises required outside input.

Outside support should focus on two major issues: the consequences of the changed concept necessitating a re-orientation of training, curricula, research approach, etc., and the reality that without institutional income generation, the future looks bleak indeed. The latter necessitates capacity building in consultancy and entrepreneurial skills.

7.5.2 Changed concept

- Support for transition (to a Department that delivers what is required) during the next two years while there is some sort of protection due to the Sida / SAREC input to one section of the Department.
- Joint venture with Sida?
- Assignment of a manager of change.
- This transition requires re-orientation of the staff through additional training (PRA, PTD, socio-economics, etc.) in workshops, seminars and short courses.
- Linking up with KARI's FS teams for farmer oriented practice periods.
- Similar re-orientation for 375 graduates.
- Possibly through establishment of Alumni Association.
- The transition also requires changes in the curricula.

7.5.2 Income generation

- As all over the world, also the Department will have to generate income.
- The manager of change is to support the Department to re-orient itself from passive donor dependency to active, institutional income generation.
- The most obvious opportunity is in the field of consultancies.
- Training to improve such consultancy skills is required.
- Training in entrepreneurial skills is required.
- The Department could be assisted (IAC?) to develop training courses.

7.5.3 Justification

The Department could approach various donors for assistance in the implementation of the points under the two previous paragraphs. Yet, despite the end of project character of this review, the team holds the opinion that there is some justification for the Netherlands Government to consider such support. In case a joint venture with Sida is possible, such support might not have to take the shape of a new 'project'.

The following arguments can be raised:

- First 10-15 years spent in building up critical mass of staff. The Department de facto existed around 1990.
- NL staff did not facilitate external contacts / expertise.
- GoN at present pays major attention to research (KARI) and extension (WEKASP); it seems logic not to ignore the third component of training. It is known that the way researchers and extensionists are trained creates a constraint to the desired changes in research and extension approaches.
- The new participatory and FS approaches in agricultural research and extension know a 'gap' where technologies are concerned; this makes the proposed re-orientation of agricultural engineering important.
- The gender aspect, since distinctive technologies are specifically related to women.

Annex I Terms of Reference

TERMS OF REFERENCE

For the end of project report of the "Assistance to the Department of Agricultural Engineering University of Nairobi (Phase IV)" (KE092030)

A. Background

(a) Objectives

The objectives of the Netherlands bilateral support to the Faculty of Agricultural Engineering of the University of Nairobi are twofold. The long term objective is to improve the carrying capacity of agricultural lands in Kenya and increasing agricultural production, through the use of technically and environmentally sound agricultural techniques, based on local technical expertise, thereby contributing to a reduction of poverty. The short term objective is to establish an adequate and sustainable educational structure in the field of agricultural engineering through the institutional strengthening of the Department by way of staff development and training, and the provision of general material support, to be achieved on the basis of a gradually reduced level of Netherlands' support during Phase IV, being the final phase of the project.

(b) Target groups

The target group for the long term objective are smallholder farmers, whereas for the short term objectives the target groups are the staff and the students of the Department of Agricultural Engineering.

(c) Project Phases

The project has completed three phases of Netherlands support and is now in the final year of phase IV. During phase I (1976-1981) the focus was mainly on developing the B.Sc. Agricultural Engineering curriculum and to launch post-graduate diploma courses in Irrigation and Soil Conservation. To serve that purpose, supernumerary teaching posts were provided as well as scholarships for staff development abroad and material inputs locally. Supplementary support was provided to construct offices and laboratories for the Department of Agricultural Engineering, which was founded in 1974.

During phase II (1981-1987), the B.Sc. Agric. Eng. was further consolidated and research work was started with the start of the Animal Draught Power Measurement Project which was integrated into the departmental activities in 1985. This research project had two basic concerns:

1. the production of improved harnesses for oxen and donkeys;
2. the extension of this technology to farmers.

The research project has continued to date (the research project itself has not received funding through Phase IV of the project. However, the research project benefited indirectly from the budget allocation for "education and research support facilities").

Phase III (1987-1992) had the objective to establish a M.Sc. programme in Agric. Eng. and an integrated research programme in this discipline. The building facilities were expanded to meet the growing needs.

Phase IV has the objective to phase out the long-lasting Netherlands institutional support in such a way that the Department will be able to continue its activities after Dutch assistance has ended.

Major activities during Phase IV are:

- a. Training four academic staff members to Ph.D. level;
- b. Providing an expatriate lecturer and project co-ordinator;
- c. Providing supernumerary lecturers recruited locally;
- d. Providing short term consultants;
- e. Providing teaching materials and research instruments;
- f. Providing training for technicians;
- g. Providing books and journals;
- h. Providing equipment and other support for developing and publishing teaching materials;
- i. Providing general support on a declining basis.

The project was reviewed in October 1982 (by A.F. Fowler and K. Kinyanjui), in August 1985 (by J.W. Kijne, D.B. Thomas, J. de Meyere, E.N. Mwaura, A.F. Fowler) and in November 1990 (by G.W. Peter, L. Speelman, F.J. Wang'ati, G.C.M. Mutiso).

B. Tasks

The review mission will undertake the tasks stipulated under (a) to (f) below with the aim of drafting an 'end of project report' focusing on the project results in relation to short term objectives and lessons learnt, and on strategies to be developed by the Department to guarantee the sustainability of the project and its achievements after the end of the Netherlands support programme on January 1st, 1996.

- (a) Achievement of short term objectives:
 - what has been the efficiency with which the project has been implemented, taking into account the following criteria:
 - i. the number of staff trained (with special emphasis on gender) and career perspectives of staff trained; what has been the impact of the project on the staff;

- ii. the number of graduates and the nature of the jobs found by them (with special emphasis on gender); what has been the impact of the project on the students;
- iii. the contribution of the project towards research and development in terms of:

- in post harvest technology;
- mechanisation including animal draft power;
- soil & water engineering;
- harnessing
- to what extent has the project supported the department in the execution of teaching and research programmes?
- what is the extent to which collaboration with other Departments, the Ministry of Agriculture, NGO's and local manufacturers contributed to the fulfilment of the short term objectives?
- to what extent has knowledge been transmitted from the staff/students to the farmers?

(b) Project execution:

- has the execution of the project in terms of lecturer/staff inputs and material inputs, including tools and equipment, facilitated and contributed to the developments in (a), and were inputs supplied as scheduled?

(c) Programme Sustainability

- taking into account the twenty years of project life, are the institutional developments, the linkages and associated programmes appropriate and sustainable, in view of - among others - the low budgetary allocation by the Government of Kenya?
- to what extent has the project been able to develop income generating capacities to improve its long term financial sustainability? If so, how successful have these capacities proved to be?

(d) Various

- which are the particular strengths and weaknesses of the project?
- which are the other positive or negative impacts of the project (including, but not limited to, environmental, economic, social and gender considerations)?

(e) Lessons Learnt

- which are the key lessons of the project regarding the points (a) up to (c) above?
- How relevant are these lessons to Kenya and other countries in the region?

(f) Recommendations

- how should the Department utilize the infrastructure, human capacity and linkages developed by the project to:
 - i. contribute effectively to rural development initiatives?
 - ii. address gender and environmental issues pertaining to the achievement of both long term and short term objectives?
 - iii. create income generating methods enhancing the financial sustainability of the project after the end of the Netherlands' support?
- which are the potential areas for follow-up programmes to be presented to potential donor agencies. How might these follow-up programmes help maximise the returns to past project investments?

C. Methodology

The review team will develop its own methodology in consultation with various interested partners. However, the team will review the project document, project reports and publications, earlier review and evaluation reports (see above A), consult the people concerned (staff, students, Ministry of Agriculture, University of Nairobi, governmental organisations, RNE, NGO's, harness makers, implement producers, small-holder farmers (including but not limited to users of animal traction related products developed by the project.)

D. Outputs

The review team will prepare a draft final report, to be submitted to the project, RNE and DGIS for their comments. The draft final report should be received by the project, RNE and DGIS on or before 29 December 1995.

E. Duration

The duration of the mission will be ten days in Kenya.

(f) Recommendations

- how should the Department utilize the infrastructure, human capacity and linkages developed by the project to:
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Annex II Itinerary and Persons met

ITINERARY & PERSONS MET

<u>date</u>	<u>place</u>	<u>met</u>	<u>function</u>
Wednesday 13/12	Dep Agr. Eng. UON do do	Dr. E Mwaura Mr. L Oudman Dr G Muchiri	Chairman Department project co-ordinator Sr. Lecturer UON
Thursday 14/12	Dep Agr. Eng. UON do do	Dr. E Mwaura Dr. F Gichuki Mr. L Biamah	Chairman Department Lecturer Lecturer
Friday 15/12	JKUAT ¹ do do do do do do do do do do	Dr. E Gumbe Dr. I Inoti Dr. B Mwaka Mr. M Abdulahi Mr. D Muturi Dr C Nindo Dr. J Nozaka Ms M Kaber J Kamanuya Ms J Okalebo Mr A Karimi	Sr. Lecturer UON Lecturer JKUAT Lecturer Egerton Mwea Irr. Scheme NIB Lecturer UON Chairman Dep Ag Eng. JKUAT Techn. Advisor MSc student UON BSc graduate UON BSc graduate JKUAT Technician UON
Saturday 16/12	Panafric Hotel do		team discussions report writing
Sunday 17/12 ²	Panafric Hotel/offices		report writing travel to Homa Bay
Monday 18/12	Faculty of Agriculture Gailey & Roberts offices	Dr. P Mbugua Mr. C Maina	ag. Dean sales executive report writing
Tuesday 19/12	Plan Int. Kiambu office MoALD Land Man. Div. MoALD Land Man. Div. MoALD Land Man. Div. offices	Mr. F. Kachwe Dr. C Osoro Mr. H Mwathe Mr F Mbote	development advisor Dep. Director Head, Irr. & Drainage Head Soil & Water report writing
Wednesday 20/12	office SCIP/MoALD/WB Sida/SAREC DGIS	Mr. R Toka Otolo Mr. T Anyengo Mr. M Koper	team discussion project engineer programme officer former resp. RNE NBO
Thursday 21/12	office office Dep Agr. Eng. UON	Dr. P Kaumbutho staff Dep, Mr. F Mollen	lecturer preparation de-briefing debriefing
Friday 22/12	office DGIS	Ms. R Bus	report writing do

¹ Conference of Kenya Society of Agricultural Engineers

² For the trip to Homa Bay the team split up. Mr. Starkey went on safari, the two other team members continued in Nairobi and environs

On Sunday 17 December, a supplementary itinerary started. On that day, one of the team members visited Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay. On the following Monday Malela Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay was visited, and on Tuesday thereafter the trip continued to Kilgoris.

During the field trip to Homa Bay, the following persons were contacted by Mr. P Starkey

Mr J Opiyo	Technician, Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Mr. J Ouko	Technician, Konuunga Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Ms R Akumu Asiyio	Donkey-using trainer, Adiedo, Kendu Bay
Mr. J Ochieng Malil	Farmer / transporter, Otok, Kendu Bay
Mr. R Ayoko	Farmer, Kadet, Kendu Bay
Mr. P Otul	Technician, Malela Divisional Demonstration and Contracting Unit, Animal Draft Power Project, Homa Bay
Mr. C Ayingi	Farmer, Malela, Homa Bay
Ms A Anyan'go	Farmer, Malela, Homa Bay
Mr A Habil Olando	Farmer, Ogongo
Mr J O Agak	Farmer, Ogongo
Mr G Kodwaro	Draft Animal Project Co-ordinator, Homa Bay
Mr T Mboya Owiyo	assistant Draft Animal Project Co-ordinator, Homa Bay
Mr B Okinyi	graduate assistant, Draft Animal Project, Homa Bay
Mr B Ombogo	District Mechanisation Officer, Kilgoris
Dr P Ondieki	Veterinary Officer, Kilgoris

During a field visit to Limuru on Wednesday, Mr. P Mwaniki a transporter / carpenter was visited.

Annex III List of Staff

DEPARTMENT OF AGRICULTURAL ENGINEERING

STAFF LIST

1. Dr. E.N. Mwaura Dip Agric. Eng. (Egerton B.Sc. Agric. Eng. (Minnesota), M.Sc. Phd Agric. Eng. Michigan)
2. Dr. L.O. Gumbe B.Sc. Agric. Eng. (Nairobi) M.Sc Agric. Eng. (Cranfield), Ph.D Agric. Eng. (Ohio).
3. Mr. G. Muchiri B.Sc. (Israel), M.Sc. Iowa)
4. Mr. E.K. Biamah Dip. Agric. Eng. (Egerton) B.Sc., M.Sc. Agric. Eng. (Oklahoma)
5. Dr. F.N. Gichuki Dip. Agric. Eng. (Egerton), P.G. Dip. Irri. (BARI). B.Sc., Ph.D. Agric. Eng. (Utah)
6. Dr. P.G. Kaumbutho B.Sc. Agric. Eng. (Nairobi), M.Sc. Ph.D. Agric. Eng. (Michigan).
7. Dr. C.M. Maende B.Sc. Agric. Eng. (Nairobi), M.Sc. Ind. Eng. (Siera Leone). *Ph.D. Newcastle*
8. Mr. R.K. Muni B.Sc. Civil Eng. (Jadarpur), M.Sc. Agric. Eng. (Roorkee).
9. Mr. D.A. Mutuli B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (Newcastle)
10. Mr. L. Oudman M.Sc. (Wageningen).
11. Mr. V.K. Serem B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (McGill).
12. Mr. G.S.N. Mungai Dip. Agric. (Egerton) (Nairobi), P.G. Dip (Silsoe) *B.Sc, MSc Michigan State U*
13. Mr. P.M.O. Owende B.Sc. Agric. Eng. (Nairobi), M.Sc. Agric. Eng. (Nairobi).
14. Mr. J.O. Odhiambo Chief Technologist
15. Mr. F.M. Mutisya Dip. Agric. (Egerton)
16. Mr. F.N. Njogu Dip. Machinery, GI I and II
17. Mr. F.K. Wanguhu Electrical Part III, II and I (Kenya Polytechnic).

18. Mr. G.E. Chweya HND Agric. Eng. (Oxford), P.G. Dip. (Israel). AGT, II and I (Kenya Polytechnic).
19. Mr. D.N. Kabuthi MET II and I (Kenya Polytechnic).
20. Mr. G.E. Onyullo Dip. Agric. (JKUAT)
21. Mr. A. Karimi Part I and II (Kenya Polytechnic)
22. Mr. S.K. Ondieki Dip. Agric. Eng. (Egerton)
23. Mr. W.M. Wamutitu
24. Mr. Z. Gichiri
25. Mr. F. Wahome
26. Mr. M. Ayuya
27. Mr. B.N. Gatonye (Deceased)
28. Mr. J. Wamwiri (Deceased)
29. Mr. C.H. Odongo (Deceased)
30. Mr. G. Njuguna
31. Mr. S. Kamendi
32. Miss E.W. Mungai
33. Mr. D. Maina.

Annex IV List of Publications

UNIVERSITY OF NAIROBI

DEPARTMENT OF AGRICULTURAL ENGINEERING

PUBLICATION LIST

DR. E.N. MWAURA:

Kijne, J.W., D.B. Thomas. de Meyere; E.N. Mwaura; and A.F. Fowler. 1985. Joint Review of the Department of Agricultural Engineering, University of Nairobi.

Munyiri, J.W.; E.N. Mwaura; and M.N. Opondo. 1987. Report on the visit to the International Trade Fair at Bucharest, Romania, 17th to 23rd October, 1987. Ministry of Foreign Affairs, Nairobi, Kenya.

Mwaura, E.N.; G. Muchiri, D.K. Some; J. Kahumbura; and P.K. Kimani. 1987. Report of the Agricultural Engineering Research Priority Formulation Task Force. KARI, Nairobi, Kenya.

Ackello-ogutu, C.A.; J.M. Bahemuka; and E.N. Mwaura. 1988. The Rural Structures Programme: A Critical Review. Ministry of Agriculture, Agricultural Engineering Division. The Rural Structures Unit, Nairobi, Kenya.

Marks, B.P.; D.E. Maier; E.N. Mwaura; and F.W. Bakker-Arkema. 1988. Optimization of the in-bin counterflow drying of corn. Paper No.88-6563. ASAE. St. Joseph, MI.

China, S.S.; E.N. Mwaura, D.K. Arap Some, J.N. Mugeto, J.N. Mutuura, and M.G. Nyambati. 1988. Rural oil seed processing in Kenya. Vegetable oil/protein System Programme, Working paper No.9 Egerton University, Njoro, Kenya.

Ackello-ogutu, C.A.; J.M. Bahemuka; and E.N. Mwaura. 1990. Reducing Post Harvest losses: Perception of farmers and extension workers in Kenya. Discovery and Innovation, Vol 2, No. 1 The African Academy of Sciences and the Third World Academy of Sciences.

Mwaura, E.N., R.G. Moreira, and F.W. Bakker- Arkema. 1993. Performance evaluation of drying of maize in an in-bin counterflow system using biomass energy. Agricultural Mechanization in Asia, Africa and Latin america. Vol. 24, No.1.

Nyaanga, D.M. L.O. Gumbe, and E.N. Mwaura. 1994. Temperature fluctuations in stored potatoes. Kenya Society of Agricultural Engineers conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Quantitative changes in some physical properties of potatoes during storage. Kenya Society of Agricultural Engineers conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Development of an equation for predicting temperature in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Mwaura, E.N. 199?. Prediction of thermal properties of cereal grains during drying (presented for publication in discovery and Innovation).

Mwithiga, G. and E.N. Mwaura. 199?. Thin layer drying equation for pyrethrum flowers (presented for publication in Discovery and Innovation).

DR. F.N. GICHUKI:

Books and Book Chapters

Gichuki F.N., Gachene C.K.K., Mungai D.N., Thomas D.B. and Biamah E.K. (In press).

Towards sustainable Land Use. Proceedings for the 4th National Land and Water Management Workshop held at Wida Motel in March 1993.

Tiffen M., Mortimore M and Gichuki F., 1994. More people, Less erosion: an Environmental Recovery in Kenya. John Wiley and Sons, UK.

Gichuki F.N. 1994. Soil Conservation. chapter II in Tiffen, Mortimore and Gichuki: More People Less Erosion: Environmental Recovery in Kenya. John Wiley and sons, UK.

Gichuki F.N. 1994. Water Conservation. Chapter 12 in Tiffen, Mortimore and Gichuki: More People Less Erosion: Environmental Recovery in Kenya. John Wiley and Sons, UK.

Hudson N., Cheatle R.J. Wood A. and Gichuki F.N. 1993. Working with Farmers For Better Land Husbandry. Intermediate Technology Publication in Association with WASWC. Exeter, UK.

Gichuki F.N. 1986. "An analysis of technical manpower needs and training activities in support of small scale irrigation development," Watering the Shamba, WMS II Report No.40, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Journal Articles

Biamah E.K., Gichuki F.N. and Kaumbutho P.G. 1993 Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27,105-12

Gichuki, F.N., Water W.R. and Merkley, G.P.: 1988. "Design and Operation Oriented Branching Canal Hydraulic Model: 1 Development" Paper submitted to ASCE, Irrigation and Drainage Division.

Gichuki, F.N., Walker W.R. and Merkley, G.P.: 1988. "Design and Operation Oriented Branching Canal Hydraulic Model II. Application," Paper submitted to ASCE, Irrigation and Drainage Division.

Merkley, G.P., Walker W.R. and Gichuki, F.N.: 1988. "Transient Hydraulic Modelling for Improved Canal System Operation," Paper submitted to ASCE, Irrigation and Drainage Division.

Allen R.G. and Gichuki F.N. 1988. Implication of Projected CO₂-induced climatic changes on irrigation water requirements in the Great Plains States, a paper submitted to ASCE, Irrigation and Drainage Division.

Gichuki F.N., Allen R.G. and C. Rosenwieg. 1988. Impacts of CO₂-induced changes in Irrigation water requirements in the Great Plains States, a paper submitted to ASCE, Irrigation and Drainage Division.

Technical Reports

Gichuki, F.N. 1994. Appropriate Water Approaches and Technologies
Mortimore, M., Tiffen M. and Gichuki F.N. 1993. Sustainable Growth in Machakos. ILEIA Newsletter 4/93.

Gichuki F.N. 1992 Indigenous Land Husbandry Practices. A Review of Indigenous Land Husbandry Practices for Improved Soil and Moisture Conservation and Crop Yield for Environmental Conservation: a Kenyan Semi-arid Areas case Study. Overseas Division SRI Report OD/92/9.

Gichuki F.N., 1992 Environmental Change and Dry-land Management in Machakos District Kenya 1930-1990: Conservation Profile. ODI Working Paper No. 56. ODI, London.

Kiome, R.M. Gichuki F.N. and Willcocks T.J. 1994. Conservation of Water and Soil for Agriculture and Environmental Protection: Research Proposal for Kenya Project. Overseas Division SRI Report OD/94/15.

Tiffen M., Mortimore M and Gichuki F. 1994 Population Growth and Environmental Recovery: Policy Lessons from Kenya. IIED, Gatekeeper Series No.45.

Gichuki F.N. 1992. Agricultural Water Management Systems in Semi-arid and Arid Areas of Kenya, Department of Agricultural Engineering Report.

Gichuki F.N. 1992. Jua Kali Sprinklers Study, report submitted to Terra Nuoga.

Gichuki, F.N., Njuguna, S.G., and Muthuri, F. 1992 Drainage Impact Study, report submitted to Ministry of Agriculture, Irrigation and Drainage Branch.

Wangati F., Muchena, F., Gichuki F.N. and Sharma, T.C., 1992. Soil Erosion and Nutrient Loss Monitoring Programme, report submitted to Ministry of Agriculture, Soil and Water Conservation Branch

Gichuki, F.N. 1991 Drainage manual for smallholder drainage projects Willcocks T., Gichuki, F.N. and Mwanda C. 1991. Development of conservation tillage systems at EMI ASAL programme. Report submitted to EMI, Embu.

King, D.L. and Gichuki F.N.: 1988. Operation oriented canal simulation model, Water Operation and Maintenance, USDI, Bureau of Reclamation Bulletin No.145.

Gichuki F.N. 1988. Development of a branching canal network hydraulic model. WMS II Report No. 72, Development of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Gichuki, F.N. 1988. Users' manual for the USU main system hydraulic model. WMS II Report No.73, Department of Agricultural and Irrigation Engineering, Utah State University, Logan, UT.

Gichuki, F.N. 1988. Application of the USU hydraulic model. unpublished report submitted to the U.S Bureau of Reclamation, Operation Section, Denver.

Allen R.G. and gichuki F.N. 1988. Effects of projected CO₂-induced climatic changes on irrigation water requirements in the Great Plains States (Texas, Oklahoma, Kansas, and Nebraska), a report submitted to U.S. Environmental Protection Agency.

DR. KAUMBUTHO P.G.

Kaumbutho P.G., 1989. Using Bond Graphs in the Design of Dynamic Systems. Kenya Engineer; Journal of the Institution of Engineers of Kenya. Nov./Dec. 1989.

Biamah E.K., F.N. Gichuki and P.G. Kaumbutho. 1993. Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27 (1993) 105-123; Elsevier Science Publishers B.V. Amsterdam.

Owende P.M., P.G. Kaumbutho and J.N. Kamau. 1994. Mounted Implement for Sugarcane Stool Destruction. AMA Journal Agricultural Mechanization in Asia, Africa and Latin America. vol 25. No.2, 1994.

Awiti L.M., D.K. A. Some, P.G. Kaumbutho and L. Masimba, 1989. Sugar Production cost Study. Kenya Sugar Authority publication 1989.

Marennya, M.O. and P.G. Kaumbutho. 1993. Sugarcane Mill Yard Operations - The Development and Application of the "MSC-MYSM" Simulation Model. Paper presented to The International Conference of the Kenya Society of Agricultural Engineers, August, 3-6, 1993, University of Nairobi, Kenya.

Kaumbutho, P.G. and S.M. Makome, 1989. Safety as observed in selected environments of Kenyan manufacturing Industries. Paper presented to the management personnel of Kenya Breweries Ltd., General Motors (Kenya) Ltd., and B.A.T., (Kenya) Ltd., companies.

Marennya, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology.

Marennya, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in asia, Africa and Latin America (AMA)

Marennya M.O., P.G. Kaumbutho, C.M. Maende and J. Kamau 1993. An operational System Model for Sugarcane Mill Yard operations. Paper submitted to the African Journal of Science and Technology Series March 1993.

Gebresenbet G. and P.G. Kaumbutho, 1994. Comparative Analysis of the Field Performance of a Reversible animal-Drawn Ard-Mouldboard Plough and Conventional Mouldboard Ploughs. Paper presented for publication to the Journal of Soil and Tillage Research. July, 1994.

Marennya, M. P.G. Kaumbutho and J.N. Kamau. 1994. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operation. Discovery and Innovation. Journal of African Academy of Sciences. Box 14798, Nairobi. Kenya.

Kaumbutho P.G., L.M. Awiti and D.K. a. Some,, 1989. Survey of Cane and Sugar Production costs 1989. Kenya Sugar Authority.

Kaumbutho P.G., 1989. A Systems Approach to Technical Report Writing. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

Owende P.M., P.G. Kaumbutho and C.M. Maende. 1990. Comparing Methods of Sugarcane Stool Destruction. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o/ University of Nairobi Box 30197, Nairobi, Kenya.

Njau F. and P.G. Kaumbutho 1994. An Investigation on Noise Safety in Selected Environments of Kenyan Industries. Paper to be submitted to Safety Journal, USA.

Owende P.M. and P.G. Kaumbutho 1994. Machinery Testing as a Primer for Appropriate Agricultural Mechanization. Paper presented at the All Africa Engineers' Conference. Nairobi, December, 14-16, 1994

Kaumbutho P.G., E.G. Karuri and L.M. Awiti 1994. analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1994. Kenya Sugar Authority.

Mr. D.A. Mutuli.

Mutuli, D.A. (1988). "An Investigation into the effect of cultivator Design on seedbed preparation". Proceedings of the Annual Postgraduate Research Conference, University of Newcastle Upon Tyne, England.

Mutuli, D.A. (1992) "Advances in Agricultural Machinery Technology towards sustainable Development", proceedings of the KSAE Annual Seminar, 5-7th August.

Marennya, M.O., Kaumbutho, P.G. and Mutuli, D.A. (1993). "An operational systems Model for Cane yard operations". Paper accepted for publications in the ANSTI Journal (African Journal for Science and Technology).

Marennya, M.O. Kaumbutho, P.G. Mutuli, D.A. and Kamau, J.N. (1993) "Simulation of the Materials Handling System a Sugar Mill Yard case study", paper accepted for publication in the AMA Journal.

Shitanda, D., Mutuli, D.A. and Odongo, F. (1994). "Indigenous Vegetable Oils in Kenya as a Diesel Fuel". In Proceedings of the Kenya Society of Agricultural Engineers' 1994 International Conference august, Nairobi, Kenya.

Mutuli, D.A. (1994) "Agricultural Mechanization in Kenya: A Review of Policies and Strategies to date". In Proceedings of the Kenya Society of Agricultural Engineers (KSAE) International Conference August, Nairobi, Kenya.

Mutuli, D.A. (1994). "The Role of Agricultural Engineering in Food Manufacturing". In proceedings for the Kenya Institute of Food Science and Technology Conference, Nairobi, Kenya, November 7th - 9th.

Mutuli, D.A. (1994) "Some Engineering opportunities for the Sustainable Development of African Agriculture" Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Shitanda, D., Mutuli, D.A. and Odongo, E. (1994). "Renewable Energy Resources for Sustainable Development", The case for Diesel Fuel substitutes". Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Marenja, M.O., Mutuli, D.A. and Kaumbutho, P.G. (1994) "Simulating Sugarcane Mill Yard operations". Proceedings of the FAOE/IEK All Africa Engineers Conference, December, Nairobi, Kenya.

Mutuli, D.A., Gumbe, L.O. and Sharma, T.C. (1994) "Review of the Drop/Check Structures Manual "Report of findings from a study carried out for the irrigation and Drainage Branch, Ministry of Agriculture, Livestock and Marketing, Government of Kenya, Nairobi.

Mutuli, D.A. et al (1994) "The GOM/ADF Malawi Agricultural Sector Study: A report of findings submitted to the Government of Malawi.

MR. MOSES O. MARENJA

Marenja, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology.

Marenja, M.O., P.G. Kaumbutho, D.A. Mutuli and J.N. Kamau 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA)

Marenja, M.O. and P.G. Kaumbutho, 1993. Sugarcane Mill Yard Operations - the Development and Application of the "MSC-MYSM" Simulation Model. Paper written and presented to The International conference of the Kenya Society of Agricultural Engineers, August 3-6, 1993, University of Nairobi, Nairobi.

Marenja, M.O. and P.G. Kaumbutho 1993. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operations. Submitted to Discovery and Innovations. An African Academy of Sciences Journal.

Marenja, M.O. 1994. simulating Sugarcane Mill Yard Operations. Paper written and presented to The IEK/FAOE - All African Engineers' Conference on the Role of the Engineer in Sustainable Development, December 14-16, 1994, Kenyatta International Conference Centre, Nairobi, Kenya.

Marenja, M.O. and M.W. Kabeu, 1995. the Problems and Potentials of the Kenyan Sugar Industry. Paper written and presented to The International Conference of the Kenya Society of Agricultural Engineers, December, 15-16, 1995, Jomo Kenyatta University of Agriculture and Technology, Juja, Nairobi. (In Press).

CLEOPHAS M. MAENDE

O'Callaghan, J.R. (Editor); Maende, C.M.; and Wyseure, G.C.L. (1994): Modelling the intercropping of maize and beans in Kenya Computers and Electronics in Agriculture 11:351 - 365. Elsevier Science Publishers B.V. Amsterdam

Maende, C.M. (1994): An application of a model of maize growth to maize production by small holders in Kenya Ph.D thesis, University of Newcastle Upon Tyne, U.K.

Maende, C.M. (1995): Solar driven computational model of tropical maize. Proc. of 50th Anniversary Engineers' Conference of the Institution of Engineers of Kenya (IEK) and Engineers Registration Board (ERB). Kenyatta International Conference Centre, Nairobi, 22nd - 24th November.

BIAMAH, E.K.

Biamah, E.K., I.M. Nagaya, E.M. Gichangi and R.K.K. Cherogony (1994). Microscale effects of tillage and organic manure on infiltration and erosion of a crusting soil, In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K., R.M. Chiti and R.K.K. Cherogony (1994). Trends in infiltration runoff and soil loss of unstable crusting soils. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K. and R.K.K. Cherogony (1994). Tillage technique for effective soil erosion control in Kenya: Evaluation of alternative fanya juu terrace designs. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H. E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K., C.K.K. Gachene, P.T. Gicheru and R.K.K. Cherogony (1994). Crop response in tillage and residue mulching practices in a clay soil. In: Soil Tillage for Crop Production and Protection of the Environment. Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editor).

Biamah, E.K. C.K.K. Gachene, P.T. Gicheru and R.K.K. Cherogony (1994). Seasonal variability in soil moisture due to tillage and residue mulching of a clay soil. In: Soil Tillage for Crop Production and Protection of the Environment, Proceedings of 13th International Soil Tillage Research Conference, Aalborg, Denmark. H.E. Jensen, P. Schjonning, S.A. Mikkelsen, and K.B. Madsen (Editors).

Biamah, E.K. and W.K. Yabann (1994). Training of Trainers Report on "Community participation in project planning in arid lands of Kenya." Emergency Drought Recovery Programme. Department of Relief and Rehabilitation, Office of the President, Kenya. October, 1994.

Biamah, E.K. and G.K. Maritim (1994). sectoral background profiles of arid and semi arid lands of Kenya. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. July, 1994.

Yabann, W.K., E.K. Biamah and A.J. Haji (1994). Report on "Environmental impact assessment of the Arid Lands Project (ALP), Kenya. Emergency Drought Recovery Programme. Department of Relief and Rehabilitation, Office of the President, Kenya. May, 1994

Biamah, E.K. G.K. Maritim and W.K. Yabann (1994). Report on "Grassroots Community mobilization in Kalokol, Central Turkana. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. May, 1994.

Biamah, E.K. J.K. Muketha and W.K. Sitonik (1994). Report of national seminar on "Community participation in project planning in ASAL areas of Kenya. Emergency Drought Recovery Programme, Department of Relief and Rehabilitation, Office of the President, Kenya. February, 1994.

Biamah, E.K. and R.K.K. Cherogony (1993). Djabia rainwater harvesting system for domestic water supply in Lamu, Kenya. In: Proceedings of the 6th International Conference on Rainwater Catchment Systems held in Nairobi, Kenya August, 1993.

Biamah, E.K. (1992). "Production Oriented Conservation Strategy for developing sustainable projects in Arid and Semi Arid Areas of Kenya. In: People Protecting their Land Proceedings of the 7th International Conference on Soil and Water Conservation, Sydney, Australia, September, 1992.

Biamah, E.K., J.K. Gikonyo, P.T. Gicheru and S.O. Oketch (1992b). Influence of tillage on crop water use at Kalalu, Laikipia, Kenya. Accepted for publication by the East African Journal of Sciences, Kenya August, 1992.

Biamah, E.K., F.N. Gichuki and P.G. Kaumbutho (1992c). Tillage methods and soil and water conservation in Eastern Africa. Accepted by the Journal of soil Tillage Research, Elsevier Science Publishers. The Netherlands, September, 1992.

Biamah, E.K., (1991). Soil Erosion Survey of Kaibon Catchment, West Pokot District, Study funded through and Suam River Catchment Rehabilitation Project (SRCRP) of the Kerio Valley Development Authority (KVDA). Vidman Consulting Engineers. Nairobi

Thomas, D.B., and E.K. Biamah (1991). "Origin, Application and Design of the Fanya Juu Terrace." In: Development of Conservation Farming on Hillslopes. W.C. Moldenhauer, N.W. Hudson, T.C. Sheng and San Wei Lee (Eds). Soil and Water Conservation Society ankeny, Iowa, USA.

Biamah, E.K. (1989C). "Water harvesting and Conservation techniques for increased crop and fodder production in Arid and Semi Arid Areas of Kenya." Paper presented at a workshop on ASAL's soil and water conservation, Ministry of Agriculture, Nairobi, Kenya. September, 1989.

Biamah, E.K. (1989B). Editor of proceedings of a UNEP/FAO seminar on "Soil Conservation Strategy for Africa." Accra, Ghana. August, 1989.

Biamah, E.K. (1989a). "Training Requirements in Soil Conservation for African Countries." Paper presented at the African Network of Scientific and Technological Institutions (ANSTI) annual Meeting, University of Ibadan, Nigeria, August, 1989.

Biamah, E.K. (1988b). "Evaluation of Feasible Conservation Strategies in Sub-Saharan Africa: A case study on Kenya and Malawi." In: Challenges in Dryland Agriculture: A Global Perspective. P.W. Unger. T.V. Sneed W.R. Jordan and R. Jensen (Eds.). Proceedings of the International Conference on Dryland Farming, Bushland/Amarillo, Texas, USA. 15-19 August, 1988.

Smith, J.L.; Biamah, E.K.; Otieno, J.O. (1988). "Simulating Rainfall and Soil Erosion using a Distributed Parameter Model (ANSWER)" The Kenya Engineer,, Journal of the Institution of Engineers of Kenya. July/August, 1988.

Biamah, E.K. (1988a). "Environmental Degradation and Rehabilitation in Central Baringo, Kenya." In: Land Conservation for Future Generations S. Rimwanich (Ed). Proceedings of the 5th International Conference on Soil and Water Conservation, Bangkok, Thailand. January, 1988.

Biamah, E.K., (1987). "Lessons learnt from Arid and Semi Arid Lands Development Projects in Kenya." Paper presented at a Conference on Project Identification in Developing Countries, held at the University of Manchester, U.K. September, 1987.

Biamah, E.K.; (1986). "Technical and Socio-Economic considerations in rehabilitating and conserving an eroded/denuded catchment area: A case study of the Chemeron Catchment Area, Central Baringo, Kenya." In: Soil and Water Conservation in Kenya. Proceedings of the third National Workshop on Soil and Water Conservation in Kenya. D.B. Thomas, E.K. Biamah, A.M. Kilewe, L. Lundgren, and B.O. Mochoge (Eds). September, 1986.

Thomas, D.B.; E.K. Biamah; A.M. Kilewe; L. Lundgren and B.O. Mochoge, Eds. (1986). Soil and Water Conservation in Kenya. Proceedings of the Third National Workshop, Kabete, Nairobi, Kenya, September, 1986.

Biamah, E.K. (1986). "Environmental Degradation and Conservation within the Njemps Flats and Tugen Plateau Areas of Central Baringo, Kenya." December, 1986.

Biamah, E.K.; Nyagah, C.R.J.; (1985). "Proposed Integrated Rehabilitation Programme for the Chemeron Watershed Area, Central Baringo, Kenya," Project Proposal Document, Ministry of Agriculture, Nairobi, Kenya,

Biamah, E.K.; (1985). Editor, Proceedings of a Workshop on Soil Conservation on Grazing Lands, Ministry of Agriculture, Kenya.

Biamah, E.K. (1984). "Soil and Water Conservation in Kenya; Concepts and Practices" Unpublished Manuscript, Nairobi, Kenya.

Biamah, E.K. (1983). "Comparison between field measurements and local climatic estimates of crop water use in Oklahoma," M.Sc. Thesis. Oklahoma State University. Stillwater. Oklahoma, USA.

SHARMA, T.C.

Sharma, T.C., Mathare catchment runoff peaks prediction by IUH, African Journal of Science and Technology (under press) 1994.

Sharma, T.C. Stochastic features of drought in Kenya, Post Conference Proceedings (peer reviewed) of the International Conference Entitled "Stochastic and Statistical methods in Hydrology and Environmental Engineering", University of Waterloo, Waterloo, Ontario, Canada, June, 1993.

Sharma, T.C., Rainsum:a criterion for design of rainwater harvesting systems, Post-conference Proceedings (peer reviewed) of 6th International Conference on Rainwater Catchment Systems, Nairobi, Kenya, August, 1993, 419 - 427.

Sharma, T.C., A. Markov model of longest dry and wet spells and largest rainsums in Kenya, East Africa, Proceedings (under print), 50 Years of Water Engineering in South Africa University of Witwatersrand Johannesburg, South Africa, 14 - 15 July, 1994.

Sharma, T.C., A mathematical rainfall simulator, Proceedings of the annual seminar of Kenya Society of Agricultural Engineers, Kabete, Nairobi, August, 1990.

Sharma, T.C., A probabilistic study of drought duration in Kenya Proceedings of the Annual Seminar of Kenya Society of Agricultural Engineers, Jomo Kenyatta College of Agriculture and Technology, Nairobi, Kenya, August, 1991.

Sharma, T.C., Sediment rating curves revisited, Proceedings of the Annual seminar of Agricultural Engineers, Jomo Kenyatta College of Agriculture and Technology, Nairobi, Kenya, August, 1992.

Sharma, T.C., A Markov model for critical dry and wet days in Kibwezi, Kenya, Proceedings of the 4th National Workshop on Land and Water Management in Kenya, Nairobi, Kenya, February, 1993.

Sharma, T.C. Some conceptions about sediment rating equations, Proceedings of the 4th National Workshop on Land and Water Management in Kenya, February, 1993.

Sharma, T.C., ARMA Models for flow forecasting in African tropics, abstracted in Pre-conference Proceedings of the International Conferences entitled "Stochastic and Statistical Methods in Hydrology and Environmental Engineering", University of Waterloo, Waterloo, Ontario, Canada, June, 1993.

Sharma, T.C. Hydrology of rainwater catchment systems: an overview, Pre-conference Proceedings of 6th International Conference on Rainwater Catchment Systems, Nairobi, August, 1993.

Sharma, T.C. Potential of instantaneous unit hydrograph for runoff peak prediction in a Kenyan catchment, Proceedings of the 6th South African National Hydrology Symposium, Pietermaritzberg, South Africa, September, 1993.

Sharma, T.C., An application of drought severity analysis for water resources systems design, Proceedings of Institution of Engineers Kenya Seminar, Nairobi, Kenya, 23 - 25 March 1994, 14 - 20.

DR. L.O. GUMBER

Gumber, L.O. and Maina, B.M. (1989): "Elastoplastic constitutive parameters for Rice En-Masse", Kenya Journal of Science and Technology, Vol. 10.

Gumbe, L.O. (1989): "Physical Properties of Coffee": to be presented at the Summer Conference of the American Society of Agricultural Engineers, Quebec City, Canada, June 25 - 28.

Gumbe, L.O. (1989): "Mechanical Properties of Coffee", proceedings of the 11th International Congress on Agricultural Engineering, Dublin, Ireland, September 4-8.

Gumber, L.O. (1989): "Physical Properties of Grain Affecting Silo Pressures", proceedings of the 10th International Symposium on Agricultural Engineering, Beijing, China, September 12 - 15.

Gumbe, L.O. and Maina, C. (1988): "Friction Coefficient of Cereal Grains on Various Surfaces", Journal of AMA, Paper No. 869, Tokyo, Japan.

Gumbe, L.O. (1988): "Considering Material Behaviour in Silo Design". Kenya Engineer, March/April, 1988.

Gumbe, L.O. (1988): "Prediction Equations for Loads in Grain Silos", paper presented at NSAE/CIGR Symposium, September 4 - 10, Lorin Nigeria.

Gumbe, L.O. (1987): "Energy for Agriculture including Energy plantation: Special Case of Biogas Slurry System for Small-Scale Kenyan Farmers", paper presented at the Former DAAD Scholarship Holders Seminars, October 22 - 24, Nairobi, Kenya.

Gumber, L.O. and Muchiri, G. (1983): "Biogas Slurry Systems, Biogas for Rural Development, CSC Technical Publication No.137.

Gumber, L.O. (1983): "Appropriate Technology and Prospects in Grain Storage", Kenya Institute of Food Science and Technology Journal, Vol.1 No.3.

Gumber, L.O. (1983): "The BSc. Agricultural Engineering Course", Paper presented at the Agricultural Engineering Inter-University subject Meeting, September 5 - 10, Arusha, Tanzania.

GICHUKI MUCHIRI

Gichuki Muchiri (1979). "Development of Tillage and Equipment Systems in Kenya". Proceedings of Appropriate Tillage Workshop IAR Zaria, Nigeria. Common wealth Secretariat.

Gichuki Muchiri (1981). "Agricultural Machinery Production and Use in Kenya". Country Position Paper, UNIDO, VIENNA.

Gichuki Muchiri and Francis N. Gichuki (1982). "Conservation Tillage in Semi-Arid Kenya". Proceedings of a Second National Workshop on Soil and Water Conservation in Kenya. Institute of Development Studies occasional paper No. 42. Edited by D.B. Thomas and W.M. Senga.

Gichuki Muchiri (1984). "Farm Equipment Innovations for Small Holders in Semi-Arid Kenya". Chapter 3.0 in Farm Equipment Innovations in Eastern, Central and Southern Africa. Edited by Iftkhar Ahmed and Bill Kinsey. Gower.

Gichuki Muchiri (1985). "Development of Ox-drawn Equipment in Kenya". In "Excess Agricultural Machinery Manufacturing Capacity in Kenya." By Iftikhar Ahmed. Geneva Vienna.

Gichuki Muchiri, Timothy Simalenga, Nokwazi Moyo (1994). "Methodological Guidelines for Agricultural Mechanization Strategy Formulation". AGROTEC, Agricultural Operations Technology for Small Holder Farmers in East and Southern Africa.

Republic of Kenya, Ministry of Agriculture, Livestock Development and Marketing (1994). "National Agricultural Mechanization Strategy (NAMS) Formulation for Kenya". Final Report. Written: Mr. Gichuki Muchiri (Project Coordination), Mr. D.M.M. Mutiga, Dr. J.G. Kariuki and Mr. J.C. Boit.

publicat.lis/3.4.96.sm.

**Annex V Comments by the Academic Staff on
the Draft Report**

DEPARTMENT OF AGRICULTURAL ENGINEERING END OF THE PROJECT
REVIEW REPORT

Comments by Academic Staff

INTRODUCTION:

- 1.0 The twenty year project has been extended four times based on evaluation of each phase and strong recommendations by the evaluation teams.
- 2.0 The last three evaluations were bilateral and were conducted on the basis of an agreed terms of reference and membership of the team. It is instructive to note that the end of the project review was unilateral. The donor actually turned down suggestions for a more balanced disciplinary representation and deliberately rejected inclusion of an agricultural engineer.

- 3.0 The terms of reference for the current review focused on:

- achievement of short-term objectives
- achievement of long term objectives
- sustainability of the project.

The review team and academic staff concur on the short-term objectives namely:

- strengthening of teaching and research capacity of the Department of Agricultural Engineering.

They are also agreed that the short-term objectives were achieved satisfactorily by 1990 i.e. fifteen years from inception.

- 4.0 There is a major difference of opinion on the interpretation of the long term objectives and what might constitute their achievement. The statement contained in the terms of reference given to the review team states the long terms objective as follows:

- to create a development impact on Kenya's agriculture.

The evaluating team decided that the impact must be perceived at farm level and by the small-holder in particular. They went ahead and wrote a whole chapter 3.0 defining the criteria they would use to assess the impact namely:

- ability to diagnose problems, design and implement solutions with the farmer using the Farming Systems Approach to Development (F.S.D.).

This write up was backed up by a systematic methodology used in discussion, examination of research project reports and field interviews conducted.

5.0 Academic staff of the Department who implemented the project view the long-term objectives differently. To them the creation of development impact on the Kenyas agriculture at all levels, can be achieved indirectly and at best it can be only a small fraction in the National development effort involving several ministries, parastatals, and all the Departments in the four Kenyan Public Universities who have initiated programmes in Agriculture, Veterinary and Engineering. Moreover there is a very active private sector development including NGOs. If the team seriously wanted to know the small contribution from the project - an impossible task in ten days - they would have evaluated the agricultural sector as a whole and thus identify the main constraints to agricultural development and small-holder agriculture in particular. At the very least they would have read numerous reports by the Government, World Bank, FAO among others. They would have discovered that FSD is not yet a National strategy even in the Central Ministry of Agriculture, Livestock Development and Marketing. It is certainly not incorporated in the teaching of MSc or BSc in Agriculture or Diploma level in any of our Universities. Scientists are infact not yet agreed on its definition. However everybody agrees that it is a major discovery by socio-economists, albeit rather late, and in Kenya, KARI has been given the mandate to experiment with it and to incorporate it in the National Research Programme.

6.0 In our opinion it is unrealistic to expect BSc Agricultural Engineering Scheme of study to include farming systems content aimed at giving the undergraduate the capacity to diagnose problems at farm level, design solutions and implement them. If he did this he would be playing the role of:

- agricultural researcher
- agricultural extensionist as well as (his own)
- agricultural engineer.

7.0 In the four years currently available for BSc engineering training (the first year is used for preparatory courses) we are expected to turn out a graduate who can analyse a problem in its scientific context, design and specify details and procedures for implementation. It is left to the on job training for engineers to learn how to carry out a detailed project identification, design and implementation. A classical example of how this can be done and is infact being done is in the Ministry of Agriculture in Irrigation and Drainage project and Coffee Factory Engineering section of the Small-Holder Coffee Improvement Project.

Ironically the team had time to travel to South Nyanza - Homa Bay to meet farmers but on the way failed to see many engineering projects such as South West Kano Irrigation Scheme, Small rice rehabilitation project, small scale wheat and rice mechanisation and post-harvest projects.

They wanted to know whether we have reached the farmer through one of our smallest project namely: Draft Animal Power project (DAP).

- 8.0 One third of the core 47 pages of the draft report are devoted to DAP. This includes one chapter 3.0 which is meant to justify the criteria used to evaluate project impact. In chapter 4.0 specifically devoted to the discussion on achievements, 4 out of 9 pages are on DAP. Finally a full page 49 on recommendations is about DAP.

In contrast curriculum development which is the main function of the Department is covered in 1½ pages, 28 and 29 in chapter 2.0 and Department research thesis and publications are dealt with in one paragraph in chapter 4.0.

Without slighting the National and International importance of DAP in sub-sahara Africa it is fair to say that the project did not until recently attract staff or student research interest. The main cause for this emanate to the unscientific approach adopted by the initiators of the project who wanted to popularise the technology before doing research and development. Naturally there is very little impact. The project did not require the recommended Farming Systems Approach orientation for staff because farmers were heavily involved since they were already using the technology. What the Department should do (and has now 2 PhD candidates on the project) is to analyse the physical and biological factors that determine the draft power available and to improve equipment design.

Once the technology is specified fully including the design of harnesses and associated equipment, an extension package will be synthesised and should include:

- Engineering specifications and standards for the manufacture of equipment.
- training and extension software for farmers
- finance for the purchase of animals and equipment.

Unfortunately farmers cannot explain why the extension package has not come about. If the team had investigated the matter they would have found the right answers. But that would have been a misdirection of effort because DAP is only one of the energy sources that the department is concerned with, Others include: human power, biomass energy, solar, wind, and fossil fuels. The energy is applied to all the areas of agricultural engineering including:

- field operations and transport
- post harvest processing, preservation and storage
- soil conservation
- water harvesting and storage
- irrigation and drainage.

9.0 Other activities in the Department including research thesis and publications received little attention. This biased approach adopted by the team is a result of misconception as to what agricultural engineering is all about and what the long term impact of the department might be.

10.0 Although the team was given a report on the Departments efforts to revise the curriculum, no time was devoted to a discussion on the criteria the staff of the department, together with farmers and other users of agricultural engineering graduates, had developed over three days of brain storming. Paradoxically the team went ahead and suggested that about 60% of courses can be dropped to make way for farming systems orientation. The criteria used in arriving at this figure is not discussed. Moreover no experience in Africa or Asia has been quoted to verify the effectiveness of these proposals.

RECOMMENDATIONS:

11.0 The above observations by the academic staff suggest that although we agreed with the team on the long term contribution to the economy and to the agricultural sector in particular, there was a major difference of opinion with regard to the nature of our contribution and more so as to the actual functions of the department in making that national contribution. We therefore wish to make positive recommendations to the Netherlands Government on how the good project achievements can be sustained in the long term as we perceive our long term objectives.

12.0 A third party reading the report is likely to be influenced and mislead by several terminologies such as ivory tower, green revolution, high tech, high input, top-down, participatory, farmer oriented, which are not defined and sweeping statement such as (in chapter 3): 'the team will describe the developments and fundamental changes that took place in the thinking about agricultural production in East Africa; the transfer was made from high-tech, high input, and top down Green Revolution' thinking to a participatory, farmer oriented approach'. In chapter 3.0 the team admits that T and V which is the main strategy for agricultural extension in East Africa supported by World Bank, is top down and not farmer oriented, thus the thinking in Kenya and the World Bank may not have changed as suggested. On the other hand the team strongly states that the Department staff had not changed for the last twenty years while at the same time noting, as commendable, the recent Department effort to revise the curriculum in the right direction.

Recommendation. (i) To clear these differences and contradictions there is a need to have a truly bilateral evaluation exercise as soon as possible.

FUTURE ROLE:

- 13.0 The crucial issue is the future role of the Department as perceived by the staff and as to the nature of the enabling environment. The output of an end of the project evaluation must be to show clearly the way ahead not in ambiguous philosophical terms but in practical way that is not only understandable but realistic in the eyes of the implementor. (see recom. i)
- 14.0 The question of orientation of staff which the evaluators call managed change is important. In our view what is required is dialogue to create the necessary awareness. Externally managed change has serious implications which are better left out of this report (see recom. i).
- 15.0 Whatever good ideas that can come from the bilateral evaluation and ensuring staff orientation, nothing will be achieved and sustained unless basic budgetary provisions can be guaranteed. The team is right in concluding that GOK current budgetary provision are stretched to the limit. Extra cash has to come from income generating activities that the Department can create such as consultancy and inservice courses.

Recommendation (ii)

It is recommended that funds be raised to revitalise the Departmental Consultancy unit and in liaison with the College Entrepreneurial Committee look in ways and means of revitalising consultancy activities in a group instead of the current individualised approach.

- 16.0 Accepting positively the observation by the review team on lack of an integrated departmental research strategy, academic staff agreed:

- to review the national policies and strategies namely,
 - Agricultural Mechanisation
 - Irrigation and Drainage
 - Soil and Water conservation
 - Energy in agriculture

and thereafter extract what might be the Department Research role. With this background each staff member will identify his or her research interest. With the two inputs the department can harmonise National research goals with individual goals and thus define an integrated approach.

Recommendation (iii)

The Departmental staff will carry out the preliminary work suggested in 16 above and therefore plan a workshop to discuss its research policies and strategies for the future. Financial support for this exercise would be appreciated.

- 17.0 After looking into recommendations (i), (ii) and (iii) the capacity to implement a revised curriculum will be assessed. An immediate consideration will be how to carry out a major revision as agreed in the Department on this matter.

recommendation (iv)

It is recommended that the Netherlands government consider supporting a major curriculum review and revision exercise.

18. Sustainability of the Department functions and operations once clearly defined will depend on the attitude and morale of the staff who are expected to implement the programmes. In addition to the regular teaching and research the staff should develop a capacity to identify, design and implement a real world project which is bankable.

Recommendation (v)

There is a need to provide seed money to write a market oriented project proposal relevant to agricultural engineering and with a long term potential for income generation for the Department and staff.

REQUEST:

- 19.0 If the consultants wish to maintain their position and agrees with donor to circulate the review, we would humbly request that these comments be circulated with the report as an appendix.

Dr. Kaumbutho

PUBLICATIONS

Undergraduate (Project) Thesis:

Design and Performance Test of a Chain Washer Irrigation Pump.

M.Sc. Thesis:

Development and Performance Test of a Three Point Hitch Dynamometer for Tillage Energy Research.

Ph.D. Dissertation:

A Bond Graph Model for Simulating the Performance of a Farm Tractor.

Kaumbutho P.G., R.C. Rosenberg, T.H. Burkhardt and A. K. Srivastava. 1987. Tractor Performance Simulation Model Using Bond Graphs. Paper No. 87 - 1503, American Society of Agricultural Engineers, St. Joseph, MI. 49085 - 9659. USA.

Kaumbutho P.G., 1989. Using Bond Graphs in the Design of Dynamic Systems. Kenya Engineer; Journal of the Institution of Engineers of Kenya. Nov/Dec. 1989.

✓ Biamah E.K., F.N. Gichuki and P.G. Kaumbutho. 1993. Tillage Methods and Soil and Water Conservation in Eastern Africa. Soil and Tillage Research Journal, 27 (1993) 105-123; Elsevier Science Publishers B.V. Amsterdam.

✓ Owende P. M., P.G. Kaumbutho and J.N. Kamau. 1994. Mounted Implement for Sugarcane Stool Destruction. AMA Journal Agricultural Mechanization in Asia, Africa and Latin America. Vol 25. No.2, 1994.

Awiti L.M., D.K. a. Some, P.G. Kaumbutho and L. Masimba, 1989. Sugar Production Cost Study. Kenya Sugar Authority publication 1989.

P.G. KAUMBUTHO

- X Kaumbutho P.G., S.M. Ithula. 1990. The Status of Agricultural Mechanization in Kenya - Now and into the Future. Proceedings of the 2nd Symposium on Science and Technology, September 11-13, 1990. Research Council of Zimbabwe, Scientific Liaison Office, P.O. Box 8510, Causeway. Zimbabwe.
- X Kaumbutho P.G., D.K.a Some and L.M. Awiti. 1990. Analysis of Sugarcane and Sugar Production Costs. November, 1990. Kenya Sugar Authority.
- X Kaumbutho P.G., 1991. Principles of Costing of Operations of Land Preparation, Cultivation and Sugarcane Transport. Lecture paper presented at the Workshop on Sugar Production Costs under the auspices of the Kenya Society of Sugarcane Technologists. Kisumu, Kenya.
- ✓ Owende P.M., P.G. Kaumbutho, C.M. Maende and J.N. Kamau. Comparison of Options for Sugarcane (*Saccharum Officinarum* L.) Stool Destruction. Paper accepted for Publication by the *Soil and Tillage Research Journal*. December 1994. *Published*
- X Kaumbutho P.G., 1991. Efficiency Considerations in the Performance of the Sugar Industry. Lecture paper presented at the Workshop on Sugar Production Costs under the auspices of the Kenya Society of Sugarcane Technologists. Kisumu, Kenya.
- X Kaumbutho P.G., D.K.a Some and L.M. Awiti. 1991. Analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1991. Kenya Sugar Authority.
- ✓ Kaumbutho P.G., 1992. Options for Agricultural Mechanization of Sugarcane Production and Transport Operations. Proceedings of the Workshop on the National Mechanization Strategy (NAMS). February 26-28, 1992. Ministry of Agriculture, Agricultural Engineering Division. P.O. Box 30028, Nairobi, Kenya.
- ✓ Kaumbutho P.G. 1992 Options for Agricultural Mechanization of Sugarcane Production and Transport Operations. Proceedings of the Workshop on National Agricultural Mechanization Strategies for Kenya. Masinga February 1992.
- ✓ Awiti L.M., Kaumbutho P.G. and D.K.a Some. 1992. Analysis of Sugarcane and Sugar Production Costs for the Kenyan Sugar Industry. December, 1992. Kenya Sugar Authority.
- X Kaumbutho P.G. and G. Mwago. 1993. Feasibility Evaluation of Alternative Agricultural Mechanization Options for the Production of Sugarcane, Rice and Wheat in Kenya. Ministry of Agriculture, Agricultural Engineering Division. May, 1993.
- ✓ Kaumbutho P.G., Awiti L.M. and E.G. Karuri 1993. Analysis of Sugarcane and Sugar Production Costs: The Liberalized Kenyan Sugar Market. December, 1993. Kenya Sugar Authority.

P.G. KAUMBUTHO

✓ Marenja, M. O. and P. G. Kaumbutho. 1993. Sugarcane Mill Yard Operations - The Development and Application of the "MSC-MYSM" Simulation Model. Paper presented to The International Conference of the Kenya Society of Agricultural Engineers, August 3 - 6, 1993, University of Nairobi, Kenya.

Kaumbutho, P.G., and S.M. Makome, 1989. Safety as observed in selected environments of Kenyan manufacturing Industries. Paper presented to the management personnel of Kenya Breweries Ltd., General Motors (Kenya) Ltd., and B.A.T., (Kenya) Ltd. companies.

✓ Marenja, M. O., P. G. Kaumbutho, D. A. Mutuli and J. N. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Submitted to African Journal of Science and Technology. *(Pending - believe it or not!)*

✓ Marenja, M. O., P. G. Kaumbutho, D. A. Mutuli and J. N. Kamau. 1993. Simulation Model of the Materials Handling System in a Sugarcane Mill Yard - A Case Study. Submitted to the Journal of Agricultural Mechanization in Asia, Africa and Latin America (AMA). *Published*

✓ Marenja M.O., P.G. Kaumbutho, C.M. Maende and J. Kamau. 1993. An Operational System Model for Sugarcane Mill Yard Operations. Paper Submitted to the African Journal of Science and Technology Series March 1993.

✓ Gebresenbet G. and P.G. Kaumbutho. 1994. Comparative Analysis of the Field Performance of a Reversible Animal-Drawn Ard-Mouldboard Plough and Conventional Mouldboard Ploughs. Paper presented for publication to the Journal of Soil and Tillage Research. July, 1994. *Revised for Publication*

✓ Marenja, M. P.G. Kaumbutho and J.N.Kamau. 1994. A Micro-computer Program for Analyzing Sugarcane Mill Yard Operation. Discovery and Innovation. Journal of African Academy of Sciences. Box 14798, Nairobi. Kenya.

Kaumbutho P.G., L.M. Awiti and D.K. a. Some, 1989. Survey of Cane and Sugar Production Costs 1989. Kenya Sugar Authority.

Kaumbutho P. G., 1989. A Systems Approach to Technical Report Writing. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

Owende P.M., P.G. Kaumbutho and C.M. Maende. 1990. Comparing Methods of Sugarcane Stool Destruction. Proceedings of the 1990 Kenya Society of Agricultural Engineers Annual Seminar. August 1-3, 1990. Kenya Society of Agricultural Engineers, c/o University of Nairobi, P.O. Box 30197, Nairobi. Kenya.

✓ Njau F. and P.G. Kaumbutho 1994. An Investigation on Noise Safety in Selected Environments of Kenyan Industries. Paper to be submitted to Safety Journal, USA. *Not yet*

- Similar paper published 1995 in Soil & Tillage Research
- Another in AMA (different content) in AMA

Mwaura, E.N., R.G. Moreira, and F.W. Bakker-Arkema. 1993. Performance evaluation of drying of maize in an in-bin counterflow system using biomass energy. *Agricultural Mechanization in Asia, Africa and Latin America*. Vol. 24, No. 1.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Temperature fluctuations in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Quantitative changes in some physical properties of potatoes during storage. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Nyaanga, D.M., L.O. Gumbe, and E.N. Mwaura. 1994. Development of an equation for predicting temperature in stored potatoes. Kenya Society of Agricultural Engineers Conference, Nairobi, August, 1994.

Mwaura, E.N. 199?. Prediction of thermal properties of cereal grains during drying (presented for publication in *Discovery and Innovation*).

Mwithiga, G. and E.N. Mwaura. 199?. Thin layer drying equation for pyrethrum flowers (presented for publication in *Discovery and Innovation*).

July, 1995.