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EQUIPMENT AND TILLAGE INNOVATIONS FOR SMALL-SCALE FARMS IN KENYA SOME UNANSWERED QUESTIONS (WITH SPECIAL EMPHASIS ON DRYLAND i.e.MEDIUM POTENTIAL AREAS)

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Abstract

This paper has been prepared for the purpose of eliciting factual information and well informed judgements concerning some specific questions related to the potential contribution of equipment and tillage innovations to increasing agricultural productivity in Kenya. The focus is on innovations capable of easing the seasonal bottlenecks which tend to reduce crop yields because of late planting and on equipment/tillage systems that will reduce run off and increase infiltrationof the limited rainfall that is received in semi-arid ("medium potential") areas. Because of the great range of choice and the difficulty of identifying implements and tillage practices that offer particular promise under various soil, climatic, and economic conditions in Kenya, it is essential to draw upon the experience and expertise of selected individuals in Kenya and elsewhere in Africa and overseas organisations such as the National College of Agricultural Engineering and the Intermmediate Technology Development Group in the U.K.

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B.F. Johnston and G. Muchiri

The purpose of this paper is to pose some important and difficult questions related to the choice of equipment and tillage innovations capable of making a significant contribution to increasing productivity in Kenya's dryland farming areas. The questions are so difficult because to answer them satisfactorily would require a combination of engineering, agronomic, economic and sociological knowledge that is not possessed by any one individual or organisation in Kenya or overseas. The importance of the questions is related to the nature of the constraints that need to be overcome in order to increase the productivity of dryland farming. Although special emphasis is given to problems related to innovations applicable to Kenya's dryland areas, a number of the questions raised are relevant to most farming areas in the country. Appropriate equipment innovations are also significant because of the favourable impact on rural industrialisation that can be expected to result from a wide and growing demand for a range of relatively farm implements that can be manufactured and maintained by small - and medium-scale workshops in rural areas.[1]

It is hoped that this attempt to formulate some specific questions that merit priority attention will help in the process of pooling knowledge available in East Africa and in research centres elsewhere in Africa and overseas, e.g. the National Institute College of Agricultural Engineering in the U.K., the International Crop Research Institute for The Semi-Arid Tropics

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1. Thus the knowledge that is required to assess alternative equipment innovations requires competence in mechanical as well as agricultural engineering in order to assess the feasibility and potential efficiency of local production by techniques which are capital-saving and which make extensive use of local materials in order to minimise foreign exchange requirements and total costs. The significance of demand for a widening range of farm equipment in fostering the growth of domestic manufacturing industries will not be elaborated upon in this paper.

in India, the UN, Industrial Development Organisation, and the Centre d'Etudes et d'Experimentation por la Machnisme Agricole located in France.[2] Drawing together existing information and informed judgement in this way should provide answers to some of the questions raised and narrow the area of uncertainty surrounding the other questions. Satisfactory answers to a number of the most important questions will obviously require research in Kenya, including comparative trials of various items of equipment and tillage practices. Such research is fairly costly and time-consuming. Local experience with animal-drawn equipment is almost entirely limited to a single type of mouldboard plough, but the range of implements that might have a useful contribution to offer is enormous. It is therefore essential to concentrate field trials on selected items of equipment and tillage practices that appear to offer particularly promising results under the economic, climatic and soil conditions that prevail in Kenya's semi-arid farming regions.

Question 1: What is the 'minimum package' of equipment and energy required to enable the typical small-scale farm unit to (i) substatially ease seasonal labour bottlenecks which have prevented the achievement of higher yields by early planting and (ii) to adopt farming practices that will achieve fuller use the limited and eratic rainfall available in dryland areas by reducing runoff and improving infiltration?

Several considerations underscore the need to emphasise equipment innovations that are inexpensive and which involve the use of[1a] range of implements that can be enlarged in an efficient sequence as individual farmers are able to expand gradually their cash receipts and their capital stock. Basically it is a consequence of the very limited resources and the low levels of income that characterise the great majority of farm households in these areas, and also of the lack of alternative employment opportunities for the fairly large population that ekes out a livelihood in this difficult environment. Farm-level surveys carried out in Kenya's dryland farming areas, although limited in their coverage, emphasise the low-levels of farm cash income and the lack of capital.[3]

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2. We have already received much valuable assistance, especially from Mr. S.D. Minto, Machinery Coodinator, EAAFRO.

3. Recent evidence is provided by Dr. Diana Hunt's survey of a random sample of 205 farms in Mbere Division of Embu District, plus a more detailed study of a sample of 40 "case study households". (Preliminary reports on her research are presented in IDS Discussion Papers Nos. 166 and 180.) None of the case study households in her sample owned trained oxen or a plough, and the inventory data that reports emphasise the acute lack of equipment to augment the productivity of the labour and land available to the typical farm unit. Thus on average each of the case study households owned 1.5 jembes (hoes), 2.5 pangas (machetes), 1.25 digging sticks, and only one farm in four had an axe.

There are several reasons why it is essential to give serious attention to improving the equipment and tillage possibilities available to the rapidly increasing number of farmers in Kenya's medium potential dryland areas. The Victory type of mouldboard plough that is currently the only ox-drawn implement available appears to have several shortcomings. First, it is an all-metal plough that is not well suited to efficient production by rural workshops, and its price (about sh. 245 or $35) is high for many farmers. Secondly, it is questionable whether its design is well suited for land preparation under dryland conditions where moisture conservation is more important than turning under grass and weeds. Although it is common for farmers to use their mouldboard ploughs for inter-row cultivation, it is obviously a very inefficient implement for that operation. Furthermore, the draft required for a mouldboard plough requires the use of four oxen and even so it is usually not possible to plough until the ground has been softened by the first rains. An implement with duckfoot sweeps or a combination of a simple ard (wedge) plough and a cultivator might facilitate early planting by making land preparation possible before the first rains and by making inter-row cultivation possible. The latter would ease a critical labour bottleneck and reduce weed competition for the limited moisture available, and by keeping the soil friable it would also reduce runoff and increase water storage in the root zone.

Question 2: Would it be advisable to stimultaneously examine the potential advantages of introducing more sophisticated and expensive ox-drawn equipment such as the French Polyculteur, the Kabanyolo Tool Frame or the tool bar designed for dryland farming in Botswana? (A cinema film of the Botswana tool bar and the tillage practices developed there is available.) Although the average farm is small and subject to a severe purchasing power constraint, there are a considerable number of farmers who could probably afford and benefit from the use of relatively sophisticated ox-drawn equipment. Moreover, with sharply increased fuel costs and higher prices for tractors and spare parts, a number of farmers who have been relying on contract ploughing are likely to switch to ox cultivation because of the increased price or reduced availability of contract service. (This has in fact already occured in some areas.)

Question 3: What priority should be given to efforts to introduce improved techniques of training and controlling oxen? The experience of the Ox Research and Training Unit at Serere during the 1960's seems to indicate that oxen trained and controlled by the so-called 'Indian system' involving

the use of reins connected to a nose ring increases the effective power provided by oxen by maintaining a steady draft rather than the jerky pulling that often characterises the usual practice using only yoke chains with a second man guiding the oxen by shouts and a whip or stick. The more precise control possible with the 'Indian system' is also valuable in facilitating planting in straight rows and especially important when oxen are used for inter-row cultivation.[4] It is reported, however, that farmers are often resistant to the practice of having the noses of their oxen punched for inserting rings. Some experts state that equally satisfactory results can be obtained by using a nose clip (at some additional expense). Others contend that reins attached to the horns of the oxen provide a simple and very satisfactory alternative. (Although in Kenya, training of oxen sometimes begins before the horns have grown enough for reins to be attached.)

Question 4: Should a programme to promote wider and more efficient use of animal draft power be coupled with efforts to promote soil conservation practices? Soil erosion is a serious problem in many of Kenya's dryland farming regions. Because of (perhaps excessive) concern with these problems, compulsion was resorted to by the British colonial administration in securing the construction of terraces and other conservation works. Those measures were extremely unpopular and have left a residue of strong resentment. The success of future efforts to promote soil-conserving practices will probably depend on their being associated with an improved farming system including more efficient tillage practices, that will provide direct and visible benefits in the form of higher crop yields resulting from fuller use of available rainfall. Hence, it seems probable that early attention should be given to identifying tillage practices, such as the graded bunds and ridge and furrow system being emphasised at ICRISAT, that are feasible for small holders subject to severe purchasing power and energy constraints. However, evolvingtechnical solutions adapted to the various soil and terrain conditions found in Kenya's dryland areas will not be easy, and it will no doubt be more difficult to organise and implement farmer training programmes if they are aimed at this more ambitious objective. On the other hand, it may well represent a sounder long-run policy even though it means a slower

4. The stress placed on row planting does not imply agreement with the old orthodoxy that planting in pure stand is inevitably superior to mixed cropping. Most of the advantages that often accrue from planting, say, a cereal/bean mixture, can presumably be realized by some pattern of alternate row planting.

slower rate of progress in promoting wider and more efficient use of ox cultivation.

Question 5: How much emphasis should be given to the testing and possible introduction of ox-drawn seeders or planters? Considerable time can be saved by the use of such equipment (especially when a 'seed cum fertiliser' drill performs satisfactorily), and more accurate placement of fertiliser can be expected to have a particularly significant effect on crop yields in dryland areas. On the other hand, considerable progress will have to be made in raising the productivity and cash incomes of farmers in these areas before any significant number of them will be able to afford these moderately expensive items of equipment--or even the use of chemical fertilisers.

Question 6: How much attention should be given to efforts to assist and encourage farmers to introduce supplementary feeding of draft animals, particularly to overcome the common problems related to their poor physical condition at the end of the dry season when they are called on for their heaviest work? Several closely related questions also deserve attention. For example, what are the prospects for introducing fodder strips for soil and moisture conservation and also to provide supplementary feed for animals? What methods of conserving fodder would be most suitable for adoption by small-scale farmers? Is there a role for the hand-operated fodder choppers (chaff cutters) that are so widely used in India and Pakistan? How feasible and valuable would it be it introduce dug silage pits, perhaps lined with polythelene sheeting?

Question 7: What contributions can be expected from simple engine powered equipment for tillage? Is there now a consensus that medium (about 15 h.p.) tractors such as the 'Boshoff tractor' developed at Makerere hold relatively little promise considering their cost and limited draft because of low traction efficiency? Does The Snail, a simple and inexpensive self-propelled winch driven by an 8 h.p. engine, offer greater promise because of its lower cost and higher efficiency? Being anchored securely, a high proportion of the power available is transmitted directly to the tillage implement without being lost in wheel slip.[5] Are the difficulties so often encountered with Landmasters and other walking tractors sufficient evidence that they are not well suited to dryland farming in Kenya? Or have those difficulties been a consequence of inadequate maintenance and other support facilities that could be remedied.

Question 8: Would it be feasible and avantageous to encourage the use of tractors already available in dryland areas primarily for operations such as opening up new land or earth moving or deep ploughing or chisel

5. (See p. 6.)

ploughing(e.g. once in three years) for which the technical superriority of tractors over oxen is very great? Would the social benefits from soil conservation justify the use of government tractor services or subsidies to encourage the use of tractors for constructing conservation bench terraces or other soil-conserving devices?

Question 9: What types of implements other than tillage equipment merit high priority? As already noted, there are cogent reasons for giving high priority to equipment which is needed to ease seasonal labour bottlenecks and for the introduction of tillage practices for conserving moisture and soil. Moreover, the prospects for achieving concrete results in identifying and promoting equipment innovations are clearly dependent upon concentrating efforts on a carefully selected and limited range of innovations because of the cost and training obstacles to securing their widespread adoption by farmers. On the other hand, there are no doubt certain items of equipment that can increase the productivity of operations other than tillage which deserve attention either because they are readily available or are likely to have very favourable cost-effectiveness ratios since they are so cheap. Items that are likely to merit attention for those reasons are maize shellers, simple machines for threshing cereals and legumes, hand planters, push-type weeders such as the Planet Junior, and bags to reduce the labour requirements for picking cotton.

In addition, certain other types of equipment may deserve attention at a fairly early stage because they are technical complements to new farming practices. For example, any significant progress in promoting fodder production and haymaking is likely to generate demand for a more efficient tool than the panga for cutting grass. Is the scythe the answer to that need? Knapsack sprayers are already being used to some extent on cotton, and with rising farm cash incomes their use for applying weedicides or for spraying beans or other crops in addition to cotton may become attractive. However, the sprayers currently in use make onerous demands on farm labour because of the time required for hauling water long distances. Thus further testing of ultra-low-volume sprayers for cotton and perhaps other crops merits some attention. It seems likely that improved varieties of sorghum or bulrush millet will offer greater promise than Katumani maize in dryland areas that are marginal for cropping because they are drought reistant and not merely drought evading. However, expanded production of those crops for

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5. For additional details and comparison of The Snail with medium tractors and ox cultivation, see T.B. Muckle et al, Low Cost Primary Cultivation (National College of Agricultural Engineering, Occasional Paper No. 1, 1973).

food production will require emphasis on more palatable varieties than those currently grown and the use of a pearling (polishing) device in conjunction with existing posho mills in order to obtain a product that can compete with maize meal. Valuable work along these lines has already been carried out by the East African Industrial Research Organisation, which is an additional reason for probably giving some attention to field testing of pearling attachements for sorghum and millet.