The State of Agricultural Mechanisation in Uasin Gishu District, Kenya, and its impact on Agricultural Output

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ABSTRACT

Uasin Gishu District is a major food-producing district of Kenya but over the recent years there has been a general decline of crop yields in the district. One of the factors that affects agricultural output is the level of mechanisation and so a study was undertaken to identify the state of agricultural mechanisation in the District and assess how this has affected the yields of maize and wheat. It was found that there was stagnation in the level of agricultural mechanisation in the District, which has contributed to the decline in crop yields. It was also found that many mechanics who handle/repair farm machinery lack the right tools and equipment and, moreover, many have inadequate relevant technical knowledge with very few of them having had some formal technical training.

Keywords: Agriculture, mechanisation, Kenya

1. INTRODUCTION

In Kenya, agriculture accounts for 30% of the gross domestic product, employs about 75% of the labour force, and is a major foreign exchange earner (Republic of Kenya, 1988). Agriculture also provides raw materials for the manufacturing sector and therefore stimulates industrial growth and non-farm incomes and employment. However, despite its importance the full potential of agriculture has not been realised because of many reasons that include declining crop yields, decreasing farm sizes, inadequate use of appropriate technology, high cost of farm inputs and lack of land use policy (Republic of Kenya, 1988).

Uasin Gishu District is basically an agricultural district, producing more than one-third of the total wheat produced in Kenya (DAO, 1996). Maize, a staple food for most Kenyans, is also produced in the District in large quantities, second to wheat. Agriculture, therefore, forms the main driving force for industrialisation in the district and most industries within Eldoret (the headquarters of the District) are agro-based, utilising raw materials from agricultural products.

The outputs of wheat and maize in the District have continued to decline and this has been attributed to inadequate use of appropriate technology and high cost of inputs and poor maintenance of agricultural machinery (DAO, 2001). However, there has been no research done in the District on whether the state of agricultural mechanisation (not just 'poor maintenance of agricultural machinery') has contributed to the current low level of agricultural production. A study of was therefore undertaken to look into this.

The objectives of the study were:

- To conduct a critical analysis of the existing state of agricultural mechanisation in Uasin Gishu District
- To provide an overview of mechanisation concepts and their impacts on agriculture
- To conduct a survey of the tools and equipment, as well as spares found in the workshops offering the servicing and repairing of agricultural machines.

The research hypotheses, which were formulated to help in making reasonable conclusions, were:

- There is no significant difference between the state of agricultural mechanisation in Uasin Gishu District and that recommended for an ideal agricultural mechanisation.
- There is no significant difference between the tools and equipment used by *jua kali* (i.e. informal sector) mechanics to repair and service agricultural machines and those recommended by manufacturers.

In undertaking the study, the following assumptions were made:

- The sample of farmers considered practice agricultural mechanisation.
- The farm implements and machinery considered were those recommended by government agricultural extension officers for use by the farmers.
- The workshop tools and equipment considered are those recommended by machinery manufacturers for use by mechanics (including *jua kali* mechanics).
- For significant tests, it is expected that at least half of the
    - farmers practice correct agricultural mechanisation methods
    - *jua kali* mechanics use the recommended tools and equipment
- The other factors that affect agriculture output such as fertilisers, timing and seeds are constant.

The study was limited to wheat and maize farmers who practice agricultural mechanisation and *jua kali* workshops which service farm machinery and implements within Uasin Gishu District. The study adopted the structure conduct performance theoretical framework of analysis, which can be used to provide a model that may be used to assess the influence of mechanisation on the performance of agriculture (Ackello, 1976; Nyangito and Kimenye, 1995; Monke and Pearson, 1989; Eicher and Staatz, 1984).

2. LITERATURE REVIEW

In the beginning of human history, all crops for human sustenance were produced and prepared using the power of human muscles. Many centuries passed before the power of animal muscles was used to relieve that of humans. With the discovery of iron, tools were fashioned that further reduced the labour of human muscles. The change from hand farming to tool-assisted power farming age was at first slow, but the development of the steel plough and the tractor accelerated it beyond the wildest dreams of our ancestors (Smith and Wilkes, 1990).

It has been found that mechanisation (i.e. the use of tractors and machinery) is one of the main factors that contribute to increase in agricultural production per farm worker such that a smaller workforce is required to produce the same (if not more) output of a crop. For example, in the United States, in 1950 one farm-worker produced enough food to support three other people while in 1970, one farm-worker supported 11 people (Wennblom, 1974). [It should not be forgotten that improvements in crop varieties and use of chemicals – fertilisers and pesticides – also contributed to this.]

The development of the agricultural tractor over the years has had the main objective of maximising the transfer of the power from the engine to the wheels and power-take-off (Bashford *et al*, 1987). Thus there have been many improvements in tractor design that include: use of pneumatic tyres, use of lugs on driven wheels, adding weights on the driven wheels, driving all the four wheels, use of steel tracks instead of rubber wheels, adding cage wheels, and use of rubber belt tracks. Though each of these improvements has its advantages and limitations depending on the terrain and soil conditions, it can be said that, in general, the use of the agricultural tractor improves agricultural output per unit area of farmland.

Tractors are of no use without suitable machinery and selecting the right machinery increases the utility of a tractor (Nakra, 1987). Machinery selection decisions require careful determination of machinery costs, which include fixed costs, operating costs and timeliness cost. The economic benefit of timeliness is evaluated by the timeliness cost, which varies widely by region, crop variety, time of the season, and machine operations. Thus proper timing of farm operations, which is related to proper selection of machinery, increases the output of a crop per unit area of farmland (Chancellor and Cervinka, 1979; Hunt, 1981; Edwards and Boehlje, 1980).

The importance of proper depth of ploughing of a seedbed has been documented and though human labour and animal power can achieve optimum depth, the timeliness of operation is to be considered since humans and animals are slower than tractors (Kepner *et al*, 1977; Kaul, 1979; Musa, 1979). However, concern is growing over soil compaction due to excessive machinery traffic.

Increased agricultural output has also been attributed to timely weeding which can be achieved by use of chemicals. Application of chemicals requires the use of accurately calibrated machinery and, in large farms, tractor (Rider and Dickey, 1982; Ksiazek, 1985). Planting and application of fertiliser are other operations that need to be timely and thus require the use of properly calibrated machinery especially for large farms.

Timely harvesting reduces crop losses and, if a farm is large, a machine is necessary. Moreover, if the whole crop can be harvested, losses can be reduced further. Thus harvesters, known as combines, which harvest the whole crop, thresh and clean the grain and process the straw into animal feed have been developed (Metianu *et al*, 1983). Though combines are useful machines, they have the potential to cause excessive soil compaction especially when fully loaded.

When choosing implements or combinations of implements for farming it is extremely important that every farmer or user of farm implements should be familiar with the circumstances and conditions under which they will be used, so that he can adapt them to his own particular farming enterprise. Factors such as climate, soil type, crop, size of farm, season, topography of the crop land, power requirements, and crop cultivated formerly play an important part in the choice of the right machinery.

Any machinery (whether properly selected or otherwise) will require repair at some stage of its life. Since the manufacturers are usually far (i.e., in major towns or even outside the country), the farmer/user normally takes the machinery to the nearest workshops. In Kenya, the workshops are of two types: those that are well-equipped (and hence charge more for any work) and those that are poorly-equipped (and hence charge less for the work). The poorly-equipped workshops are more common and range from those that are just in the open air (hence the name '*jua kali*' – from the Kiswahili words for 'hot sun') to those that have temporary shelters made of iron sheets.

3. METHODOLOGY

The study adopted methodological triangulation which is a combination of both quantitative and qualitative research. In this method, qualitative work upholds quatitative work in providing theoretical framework, validating survey data and interpreting statistical relationships.

The farmers within the six divisions of Uasin Gishu District constituted the target population for the study. Questionnaires were administered to one hundred farmers who had been chosen by systemic random sampling from the population; thirty of them were further chosen randomly to participate in the interviews. General comments and observations that were considered useful were also recorded from day-to-day contacts with farmers, mechanics, customers and the public.

Research instruments used in the study included a self-administered questionnaire, interviews and direct observation/participation. The questionnaire focussed on the specific issues presented in the hypotheses, namely: agricultural mechanisation, servicing and repair of farm machinery, and tools and equipment used by the *jua kali* mechanics. Open-ended questions were used for interviewing the thirty selected farmers.

From responses, Kuder-Richardson formula was used to calculate the reliability coefficient. Results obtained from the survey were analysed using the descriptive data and comparisons were made (using chi-square) to determine whether there were significant differences between the actual state of agricultural mechanisation, services, tools and equipment in the District and those recommended for an ideal agricultural mechanisation. Since statistical analysis could not be applied to open-ended questions, responses to such questions were compared with responses from interviews.

4. RESULTS AND DISCUSSION

Tables 1, 2, 3, 4, 5, 6 and 7 show the results of location of farms, age brackets, number of dependants, highest level of education, experience in farming, scale of farming activities and growing of maize and wheat, respectively, by the 100 farmers who filled and returned the questionnaires.

Table 1: Location of farms

Division	% of farmers
Ainabkoi	15
Moiben	11
Soy	18
Kapsaret	22
Kesses	13
Turbo	21

Table 2: Age (years) brackets of farmers

	% of farmers
Less than 21	3
21 – 30	8
31 – 40	20
41 – 50	43
Above 50	26

Table 3: Number of dependants

	% of farmers
Less than 5	17
5 – 10	7
More than 10	76

Table 4: Highest educational levels of farmers

	% of farmers
Primary	20
Secondary	63
University	10
Unknown	7

Table 5: Experience (years) in farming

	% of farmers
Less than 5	17
5 – 10	7
More than 10	76

Table 6: Scale of farming

	% of farmers
Small	43
Medium	23
Large	34

Table 7: Growing of maize and wheat

	% of farmers
Both maize and wheat	96
Only maize or wheat	4

Table 8 shows the significance of use of main types of implements/machinery in the six Divisions of Uasin Gishu District.

Table 8: Implements/machinery used by farmers in the six Divisions of Uasin Gishu District

Implement/machinery	*Ainabkoi*	*Moiben*	*Soy*	*Kapsaret*	*Kesses*	*Turbo*
Disc plough	*	*	*	*	*	*
Mouldboard plough	-	-	-	-	*	-
Chisel plough	-	-	-	-	-	-
Rotary cultivator	*	*	*	*	*	*
Spring tine harrow	-	-	-	-	-	-
Sub-soiler	-	-	-	-	-	-
Spike tooth harrow	*	*	*	*	*	*
Disc harrow	-	*	-	na	-	-
Manure spreader	-	na	-	-	-	-
Maize planter	*	-	-	-	-	-
Tractors	*	*	*	*	*	*
Seed drills	*	-	-	-	-	-
Spinning disc distributor	*	na	*	*	-	*
Plate and flicker distributor	-	na	na	na	na	*
Twin roller	*	*	*	na	*	na
Star wheel	*	*	*	*	*	*
Recirculating disc	*	*	*	*	*	*
Boom sprayer	-	-	-	-	-	-
Knapsack sprayer	*	*	*	*	*	*
Combine harvester	*	*	*	*	*	*
Forage harvester	-	-	-	-	-	-

* = significant (at 5% level of significance)
\- = not significantly used
na = no data available

For each implement/machinery, the best working condition of each was looked at so that, for each Division, a particular implement or machinery would be recommended for it depending on the type of soil profile and topography. Thus for Ainabkoi Division, for example, the implements or machinery indicated in Table 8 as having insignificant use means that the specific farming activities requiring their use could not be done. Similar remarks can be made for other Divisions except that the types of implements/machinery having insignificant use differ.

The ideal plough for ploughing is the mouldboard plough, which inverts the soil completely and buries the trash so as to improve soil fertility. The insignificant use of this type of plough in virtually the whole district means that seedbed preparation has been poor resulting in reduction of crop yields. Moreover, the presence of a hardpan in most parts of the District requires the use of a chisel plough yet the use of this type of plough is insignificant.

The insignificant level of use of maize planters and seed drills in most parts of the district means that most farmers are planting their crop within the required planting season. Others may resort to using tillers and hand labour, which may affect the rate of application and placement of seed and fertiliser. The depth of seed placement and covering is also not consistent and this affects seed germination.

Quite a number of implement/machinery in use were found to be very old and could be said to be obsolete. This means that farmers are not keeping pace with improvements in technology. For example, modern combine harvesters can handle fairly wetter crop than the old ones and this means that losses that arise when the crop is left to dry in the field are reduced.

It can be said from the analyses of the six Divisions of the District that, in general, an ideal situation of agricultural mechanisation is not attainable in the whole District and therefore the hypothesis that there is no significant difference between the state of agricultural mechanisation in the District and that recommended for an ideal mechanisation is rejected.

Table 9 shows the chi-square analysis of the significance of use of main types of tools/equipment by *jua kali* mechanics to repair and service agricultural implements/machinery.

The *jua kali* mechanics require all the tools/equipment indicated in Table 9 and since the Table indicates that some tools/equipment have insignificant use, this means that the specific repair and servicing work requiring their use is not done. This indicates that the quality of work done by these mechanics is poor. For example, the lack of a torque wrench means that a mechanic could over- or under-tighten bolts and nuts which could result in loss of cylinder compression or high frictional torque and hence affect engine power output.

Thus it is evident that an ideal situation of repair and servicing of agricultural machines/implements has not been attained in the District and therefore the hypothesis that there is no significant difference between the tools and equipment used by *jua kali* mechanics to repair and service agricultural machines/implements and those recommended by manufacturers is rejected.

Table 9: Tools/equipment used by *jua kali* mechanics

Tools/equipment	*Significance*

Assorted spanners	*
Injector pump testing machine	-
Torque wrench	-
Piston ring expander	na
Stud extractor	-
Injector nozzle testing machine	-
Allen keys	-
Soft face hammer	-
Straightedge	-
Bearing puller	-
Engine compression tester	-
Bush & bearing removal set	na
Valve spring compressor	-
Tap & die set	-
Piston ring compressor	*
Air compressor	-
Trolley jack	*
Vernier calliper	-
Micrometer screw gauge	-
Dial gauge indicator	-
Feeler gauge	-
Steel rule	*
Thermometer	-
Plastic gauge	-
Engineer's square	*
Reamer machine (assorted)	Na
First aid kit	-
Welder's goggles	*

* = significant (at 5% level of significance)
- = not significantly used
na = no data available

All farmers interviewed agreed that their output of maize and wheat had declined and most of them also said that, in addition to lack of appropriate and affordable machinery, low quality seeds and high cost of fertilisers could have contributed to the drop in crop yield. Many farmers also indicated that they use particular implements/machinery due to their accessibility and not because they are the best for the specific farming activity.

Majority of the farmers indicated that they preferred dealing with *jua kali* mechanics rather than dealers and established workshops because of the cost element. However, they raised a concern about the competence and lack of appropriate tools/equipment by the mechanics. This concern is even more crucial because a large number of mechanics said they hade no formal training in repair and servicing and only learnt the trade from experience.

5. CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that:

1. The state of agricultural mechanisation is below that recommended by agricultural extension officers and this has contributed to decline in crop yields.
2. The state of *jua kali* workshops, where a majority of farmers take their implements/machinery for servicing and repair, is below that recommended by manufacturers.

Based on the research findings, the following recommendations can be made:

1. The Government of Kenya should subsidise the cost of farm implements/machinery so that farmers can acquire the right ones for specific farm operations and hence reverse the decline in crop yields.
2. The Government of Kenya should strengthen agricultural financial institutions so that farmers can access affordable loans to enable them buy the appropriate implements/machinery and hence reverse the decline in crop yields.
3. The Government of Kenya should rehabilitate the Agricultural Mechanisation Services (AMS) stations, which can assist in giving farmers technical services at appropriate times and at affordable costs.
4. The Government of Kenya should assist in upgrading the skills of *jua kali* mechanics so that they can appreciate the need for high quality work in their repair and servicing of agricultural implements/machinery.
5. The Government of Kenya should assist *jua kali* mechanics access affordable loans to enable them buy the right tools/equipment for their workshops.

6. REFERENCES

Ackello, O. 1976. The marketing of poultry and eggs in Nairobi. MSc Thesis, University of Nairobi, Kenya.

Bashford, L.L., Von Vorgen, K., T.R. Way and L. Xiaoxian 1987. Performance comparison between duals and singles on the rear axle of a front wheel assist tractor. Transactions of the ASAE, 30 (3): 641-645.

Chancellor, W.J. and Cervinka, V. 1979. Timeliness coefficients for rice and factors affecting their values. Transactions of the ASAE 17 (5): 841-844.

DAO, 1996. Uasin Gishu District Annual Report. Eldoret, Kenya: District Agricultural Office.

DAO, 2001. Uasin Gishu District Annual Report. Eldoret, Kenya: District Agricultural Office.

Edwards, W. and Boehlje, M. 1980. Machinery selection considering timeliness losses. Transactions of the ASAE 22 (2): 810-815, 821.

Eicher, C.K. and Staatz, J.M. 1984. Agricultural development ideas in historical perspectives. Transactions of the ASAE 23 (2): 520-540.

Hunt, D.R. 1981. Machinery management in areas of labour surplus. In: *Proc. Int. Conf. On System Theory and its Application*. Ludhiana, India: Punjab Agricultural University.

Kaul, R.N. 1979. Some considerations for tillage research. In: *Proc. Workshop on Appropriate Tillage*. Zana, Nigeria: Institute of Agricultural Research.

Kepner, R.A., Bainer, R. and Barger, E.L. 1984. Research and development in farm machinery on yield and fertiliser response of maize grown on a forest ochrosol. Ghana J. of Agric. Sci.

Ksiazek, T.F. 1985. Automatic controls for chemical application. In Proceedings of the Agri-Matron Conference and Exposition, 165-172.

Metianu, A.A. Tinker, D.B. and Farrant, J. 1983. Evaluation oif the prototype whole crop harvest under field conditions in Schag. National Institute of Agricultural Engineering.

Monke, E.A. and Pearson, S.R. 1989. The policy analysis matrix for agricultural development. London, UK: Cornell University Press.

Musa, H.L. 1979. Traditional tillage operations and development and use of drawn equipment. In: *Proc. Workshop on Appropriate Tillage*. Zana, Nigeria: Institute of Agricultural Research.

Nakra, C.P. 1987. Farm Machines and Equipment. Delhi, India: Dhanh Rai and Sons.

Nyangito, H.O. and Kimenye, L.N. 1995. Agricultural Development Policies in Kenya. Department of Agricultural Economics, Faculty of Agriculture, University of Nairobi, Kenya.

Republic of Kenya, 1988. Development Plan 1989 – 1993. Nairobi, Kenya: Government Printer.

Rider, A.R. and Dickey, 1982. Field evaluation of calibration accuracy for pesticide application equipment. Transactions of the ASAE 25 (2): 258-260.

Smith and Wilkes, 1990. Farm Machinery and Equipment. New York, USA: McGraw-Hill

Wennblom, R.D. 1974. The Eye watches your crops. Farm Journal, 98(2):29.