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On-Farm Experiments: Some Experiences

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In Kenya, it has been realized that a lot of research money, time, and effort has been used to derive recommendations that small-scale farmers have refused to adopt. A review of these rejected recommendations revealed that it would have been against the farmers' interests and objectives to adopt them and that the inputs required were beyond the farmers' means. Time, money, and effort would have been used more effectively if the researchers had known beforehand the objectives and resource limitations of the target group, in addition to the climatic requirements of the technology package. To achieve this broad objective, the Research Division of the Ministry of Agriculture recently started using the services of agricultural economists at the research stations. The Eastern African Economics Programme (EAEP) of the International Maize and Wheat Centre (CIMMYT) was extended to Kenya to train researchers on the job.

A farming systems approach was used, with the aim being to understand the logic of small-scale farming communities, which are the target groups. It involves finding out what farmers in a given environment are doing and why. The procedure attempts to identify changes that are possible within the system. The changes need to be small enough to be within the scope of the majority of the farmers, but they also need to have positive effects that are significant enough to justify the required reallocation of resources. Because the objective is to arrive at recommendations that are sympathetic to the physical, economic, institutional, and social conditions of the small-scale farmers, the farming system researchers are required to cooperate with researchers in the basic sciences, who see the need for this approach.

One of the basic principles of farming systems research is to try out agronomic practices in farmers' fields before formulating recommendations. On-farm experiments, also called preextension trials, are indispensable where the treatment variables are labour and timing of labour application. The labour constraint, as it exists on small-scale farms, cannot be reproduced in experiments conducted at the research station. Even in situations where experiments conducted at the stations would be much cheaper and convenient to run, on-farm trials will yield valuable information that is likely to influence the recommendations generated. Experiments dealing with fertilizer application rates illustrate this point clearly.

Firstly, the yield obtained might show no response to fertilizer application at the research station because fertilizer has been applied to these plots over many years. Secondly, in an environment where weeds or pests are the major problems faced by farmers, yield response to fertilizer application in research station trials, where weeding is carried out as often as necessary and pests are effectively controlled, might be very impressive but misleading. In fact, recommendations made on the strength of these results alone assume that farmers control pests and weeds as often and as effectively as at the research station. In this situation, on-farm trials can show the response of yield to fertilizer application when weeds and pests are controlled as often and as effectively as the farmers capabilities allow. Thirdly, it has been assumed, so far, that the farmers can afford the required amount of fertilizer per hectare. Careful monitoring of the cash resources and outlays of the farming family might reveal that the money is not available. On the other hand, the farmers might have a better use for the money after taking into account the risk of investing it in fertilizer. Considering the benefits of this approach, on-farm trials were conducted in a marginal area of Machakos District, eastern Kenya. Some of the experiences encountered are presented in this paper.

Background Information

The largest portion of Machakos District is semi-arid. In Kenya, areas receiving 500-800 mm of rainfall annually are classified as marginal or semi-arid. As pointed out by Ambrose (1964), the production of annual field crops in these areas is severely limited by the availability of moisture, but the use of crop varieties adapted to these conditions would make crop output reliable enough to support a larger population. The area has a bimodal pattern of rainfall, with the long rains occurring between March and May and the short rains occurring from late October to December. The period between the short rains and the long rains is not always dry.

Owing to the length of the rainy periods, early planting, or even dry planting, is recommended so that the crop utilizes as much of the available moisture as it needs. Growing Katumani maize, which is an early maturing composite, during the long rains poses a special problem due to the short duration of the rains. In a study by A.M. Marimi (unpublished data), it was found that an 8-day delay in planting, after the onset of the rains, reduced the yield from 2530 to 410 kg/ha (about 84% reduction) at Kampi ya Mawe. Other results similar to this have indicated that late planting is one factor that accounts for severe reductions in yield.

Usually, the farmers wait for the rains to soften the soil before plowing. It is recommended that the long rains crop be planted not later than the 1st week of March. However, the short rains maize is still in the field at this time. More time is needed to harvest and plow before the long rains crop is planted. For this reason, therefore, it is difficult for the farmer to avoid late planting of the long rains crop.

Research Station Experimental Trials

In order to generate some solutions to this problem, H. M. Nadar (unpublished data) conducted agronomic trials at Katumani Dryland Research Station (Machakos) for several seasons. Basic food crops of the area, i.e., maize, pigeon peas, and beans, were used. The findings from these trials indicated that the farmer should wait for the short rains to begin and the weeds to germinate before plowing. Where maize is intercropped with beans, the spacing between rows should be 75 cm, with a spacing of 30 cm between two maize hills. Two hills of beans are planted between two hills of maize within a row, with a 10 cm space between them. For intercropped maize and pigeon peas, the same spacing as above, is maintained for maize. The spacing for pigeon peas is 150 cm by 60 cm. If the rains fail and the farmer has applied fertilizer to the crop, not only the crop but also the cash invested in the fertilizer is lost. To minimize this risk, the effect of fertilizer applied when the crop is about 30 cm high was analyzed. It is felt that the risk of using fertilizer is minimized if the farmer applies it after observing the progress of the crop rather than applying it at the time of planting. If the crop seems likely to fail, the farmer can spare the fertilizer expenses. As mentioned earlier, January and February are not always dry. It is recommended that planting for the long rains be completed by the 1st week of March. The objective is to utilize the available moisture received in January and February as well as that available from the long rains in order to meet the crops' requirements. It was also mentioned earlier that planting cannot be timely if the land has to be plowed first. The solution to this problem as suggested by the trials, is that the long rains maize crop or maize and beans intercrop should be relay planted with the short rains crop (pigeon peas planted for the short rains mature during the long dry period).

Thus, it is suggested that three major advantages will arise from this method. (1) relay planting will allow the crop to utilize as much moisture as possible; (2) the labour requirements will be minimized because plowing will not be required before the long rains; and (3) delaying fertilizer application as specified will minimize the risk of incurring the cost of fertilizer when the crop is likely to fail.

On-Farm Trials

In October 1979, on-farm trials were started in an attempt to assess the benefits of the technology as it operates in the farmers' fields. Some small-scale farmers were selected in Machakos area with the understanding that the farmer would supply the labour for the trial plot from the usual sources; seed, fertilizer, and pesticides would be provided by the researchers; the crops grown on the plot would be the same crops that the farmers would have grown on that plot independently; the output from the plot would be retained by the farmer; and if the trial plot yielded less than an equivalent plot under the farmer's technology, the researchers would be responsible for the balance.

Because the time of planting was considered critical to the success of the technology package, it

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was important that the cooperating farmer should own a team of oxen and a plow. In addition, the farmer had to be willing to spare a piece of land large enough for the trial; carry out some farm operations as specified by the agronomist, e.g., time of planting, spacing, and fertilizer application rate; record the daily input of labour and other inputs, e.g., fertilizer, as well as the output for the whole cultivated area on the basis of individual plots; and restrain from using the output from the trial plot before samples were taken.

Owing to the problems and the cost of supervision, a group of five farmers was considered adequate as a first attempt at preextension trials. Thus, it is important to note that the data obtained are not intended for making statistical inference to the population, as would have been the case if the sample size was larger. The crop combinations chosen by the five farmers for the 1979-1980 cropping year were:

Short rains	Long rains	Number of farmers
Maize, pigeon peas	(Pigeon peas)	2
Maize	Maize	1
Maize, beans	Maize, beans	1
Maize, beans	Maize	1

Labour Input

It was not possible to verify the suggestion that relay planting the long rains crop with the short rains crop would reduce the labour requirements of four of the farmers. Two of these were the farmers who planted pigeon peas. The farmer who chose to grow maize and beans for the two seasons experienced crop failure for the entire farm during the short rains. As such, land preparation for the long rains was not delayed by the unharvested crop. The farmer growing maize for both seasons was uncooperative from the beginning of the short rains. The remaining farmer did not relay plant by the end of the 1st week of March, due to weed problems. Upon inspecting the plot, this was found to be the case, even though it had been weeded at least twice before. Two reactions were received upon suggesting that one more weeding seemed necessary. First, if the ox-drawn plow was used for weeding, the animals would destroy the mature maize crop. Second, if the weeding was done by hand, it would take a long time. As such, the old method, i.e., harvesting, plowing, and then planting was the only alternative acceptable to the farmer. If the animals would actually damage the mature crop, weeding by hand would not solve the problem because the ox-drawn plow is normally used to make furrows for planting. As a result of these differences of opinion, the farmer stopped cooperating.

The trial plot for this farmer had an area of 0.3 ha and the labour input during the short rains was:

Operation	Time required (man-hours)	Dates
Plowing and planting maize and beans	65	28 Oct - 17 Nov
Hand weeding	80	18 Nov - 26 Jan
Ox weeding	24	17 Feb - 5 Apr
Hand weeding	94	15 Feb - 5 Apr
Harvesting Maize	30	17 Feb - 5 Apr

Fifty-two man-hours were required to plow and plant maize for the long rains. Given the above labour input and the timing of this labour application, it can be concluded that at least one more weeding was required so that the plot would be clean for planting by the 1st week of March. The least amount of labour used to weed the plot by hand was 80 man-hours. Thus, one more weeding would increase the labour for weeding by at least 40% of the weeding labour used so far. In addition, this operation alone seems to require nearly as much labour as was utilized for harvesting, plowing, and planting for the long rains.

Although it is not claimed that the labour situation for the majority of the farmers in the area is as indicated here, the on-farm trial seems to indicate that there are issues that require further clarification, especially with respect to labour. It is important to find out whether the majority of farmers, with their usual number of weedings and time of weeding, have plots that are clean enough for planting by the 1st week of March. If they do not, one alternative is to look into the possibility of increasing the effectiveness of weeding to meet this objective. It seems obvious that if the number of weedings is increased the labour requirements will not be reduced, especially when the operation has to be carried out over a short period of time when the soil is not too dry or too wet to be workable. Because relay planting is an important component of the package, there is a need to assess the possibility and alternative methods of planting between rows of a mature maize crop. It is also necessary to find out whether or not omitting the plowing before the long rains has any effect on the amount of labour required later for weeding.

Some Problems Encountered

The major problem that plagued the on-farm trials was the lack of cooperation from the farmers

at a time when it was too late to choose replacements. The benefit of the technology package could only be judged after a minimum of two cropping seasons. As indicated earlier, only two of the five farmers were in a position to relay plant. However, these farmers had stopped cooperating before the time of planting for the long rains.

The problem of supervision was enhanced by the fact that the on-farm trials were conducted approximately 130 km from the station. Because daily trips were very exhausting, some of the researchers resided near the trial sites during planting, when increased supervision was necessary. Daily labour recording by a member of the family was discontinued because it was time consuming and tiring; no labour input was recorded for certain days even though some work was actually done; some of the necessary details, e.g., the number of the plots worked on, the type of work done, and the amount of time spent, were often not included; for some households, the only person who was able and willing to record the information left; a lot of time was required to read through the mass of material to extract the required information; and the missing details were detected when it was too late to rectify the situation.

From the beginning of the long rains, labour and other inputs were recorded by interviewing the farmer. It was planned that this would be done on the basis of individual plots every 2-3 weeks. The method resulted in more complete information because missing details and inconsistencies were detected and straightened out on the spot. Moreover, the time required to compile the data was reduced. However, the major problem with this method was that it was not always possible to visit farmers every 2-3 weeks due to the cumbersome procedure of completing requisitions for transportation and living allowances while in the field. Also, there were the inevitable interruptions caused by symposiums, workshops, and seminars. The method resulted in the loss of some details, e.g., if it was recorded that a certain plot was planted during the last 3-week period, no attempt was made to indicate during which of the 3 weeks the planting actually took place. In such cases, a delay in planting during the 1st week of this period could be timely, whereas planting during the 3rd week could be late. In fact, as pointed out earlier, a delay in planting of 8 days from the onset of the rains could result in 84% reduction in yield. The length of the interview depended upon the amount of activity that had been going on since the last visit. Often, some farmers were absent or unwilling to spare the time required when they were visited. In such cases, another visit was always arranged at the farmer's convenience.

Several problems were encountered in attempting to estimate the yield from the individual plots. First, some farmers used the crop from the trial plot before samples were taken, whereas others harvested and mixed the yields of plots with fertilizer and those without fertilizer. The farmers pointed out that the researchers had taken too long to take the samples after the crop was mature and that if left any longer in the field the damage would increase. For the rest of the plots, some difficulties arose when deciding what method was best for estimating the yield. One of the alternatives was to select at least three random subplots from each plot for estimating the yield of the whole plot. The farmers would be asked not to remove crops from the subplots before samples were taken. After some consideration the method was discarded because for each farmer there would be too many "forbidden" subplots over the entire cultivated area, which would inconvenience the farmer; a lot of time and labour would be required to cut and thresh the crop from the subplots for weighing; the results would be misleading if the number of different crops in the subplot were fewer than the number in the entire plot, e.g., the crop planted to utilize the area where pigeon peas are far apart might not appear in the sample; and there was a need to balance the accuracy of the different sets of data and it was thought that the accuracy of the yield data that could be obtained from this method was not matched by area, labour, and other inputs data. Instead, the farmers' estimates of the crop yield harvested dry and that utilized when green were recorded.

Conclusions

For future on-farm trials the experiences pointed out here indicate that:

(1) There is a need to carry out a presurvey of the target group of small-scale farmers before conducting on-farm trials, or better still, before developing the technology package, to determine the situation for the majority of the farmers with respect to key issues of the proposed package. In the example discussed here, it seems that there was a need to find out the number of weedings normally conducted, the timing of these operations, the conditions of the fields with respect to weeds at the proposed time of planting, and the variation in these factors on the same farm. It also seems necessary to assess the reaction of farmers to the idea of relay planting onto a mature maize

crop and establish whether this technique is new to the area.

(2) The number of farmers initially selected for the trials should be slightly more than the number required to allow for dropouts owing to a lack of cooperation.

(3) It is necessary to explain the nature and timing of the activities the farmer is required to carry out over the entire period so that those who choose to cooperate know what is expected of them.

(4) Very strict supervision is required not only during planting but also during harvesting so that samples are taken as early as possible, thus reducing the inconveniences for the farmers.

(5) The farmers selected should represent the majority of the farmers, e.g., if most of the farmers own a team of oxen and a plow, the farmers selected for the trials must have these implements.

(6) Only those farmers who have the crop combination and crop sequence that allow the effects of the technology package to be observed should be selected.

(7) Although the duty of conducting interviews with the farmers should not be delegated to junior staff, assistants should be recruited to record labour and other inputs as scheduled, in addition to increasing the interest of the cooperating farmers when the researchers themselves are not available.

(8) There is a need for the administrators of research institutions and stations to understand and provide for the needs of this research approach, which are different from the traditional approach, for it to succeed.

Ambrose, H. B. 1964. The case of intensified agricultural research in the medium potential areas of Kenya. Nairobi, Kenya. Ministry of Agriculture. (Mimeo.)

Discussion

Edelstan (question): To what extent do you involve local extension staff in the formulation of objectives and in the administration of research in the area concerned?

Muriithi (answer): The extension staff misinformed the farmers in Kenya. The majority of farmers do not appreciate the extension advice, e.g., fertilizers because of cost.