Review of pioneering pineapple research on agricultural stations of Ghana 1950-1962

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SUMMARY

The pioneering trials carried out at Pokuase, Ohawu, Mampong-Ashanti and Wenchi sought to compare pineapple cultivars for adaptability in Ghana, their yields and ratooning capacity. Studies on cost of production in relation to income were carried out. The use of the cutlass and hoe for pineapple cultivation was confirmed to be labour-intensive and some attempts were, therefore, made to use herbicides and mulches to effect weed control to reduce production cost. Simazine at the rate of 5.7 kg a.i./ha was found to be most suitable and also gave the highest yield of 22.4 t/ha. The trials also investigated the role of organic as well as inorganic manures in promoting the growth and yield of pineapple. The need for concentrating fruit harvests by effecting high percentage of flowering by the use of flower inductants was felt and some attempts were made to obtain information on this aspect also. However, none of the chemicals used was effective. It is noted that most of the trials were initiated without due consideration for statistical analysis for better interpretation of the results. The overall results of these early trials, even with their shortcomings, can be said today to confirm observations in 1934 that good pineapples can be grown and marketed in Ghana. The steady development of the industry especially within the past decade has confirmed this. What is left now is to increase the country's adaptive research capability and inject capital funding for research to sustain the tempo of growth for eventual transformation of the industry from peasant to fully modern agricultural enterprise. The need for increasing research and funding for pineapple production is discussed in the light of the results reported in the study.

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RÉSUMÉ

ABUTIATE, W. S.: *Revue de la recherche originale de l' ananas dans des centres agronomiques au Ghana, 1950-1962.* Des essais orignals effectués à Pokuase, Ohawu, Mampong-Ashanti et Wenchi dans le but de comparer des variétés cultivées d'ananas pour leurs adaptabilités au Ghana, leurs rendements et leurs capacités de pousser des rejetons. Des études sur le coût de la production vis-a-vis le revenu ont été aussi conduites. L'utilisation de la machette et de la houe dans la cultivation d'ananas a été confirmé comme nécessitant l' emploi de beaucoup de main-d'oeuvre et des éfforts ont été faits pour utiliser des herbicides et des pailles pour lutte contre des herbes afin de reduire le coût de la production. Simazine à une dose de 5.7 kg a.i./ ha a été très efficace et a donné le plus haut rendement de 22.4 t/ha. Des essais ont aussi été faits pour étudier l'effat du fumier organique et inorganique sur la croissance et le rendement d'ananas. Le besoin de concentrer la récolte comme le moyen d'effectuer une pourcentage plus élevée de la floraison due à des agents chimiques était résenti et des efforts ont été faits pour obtenir des informations sur ces aspects aussi. Aucun des agents chimiques n'a été effectif. Il a été constaté que la plupart des essais a été initiées sans la moindre considération à l'analyse de la biomasse pour bien interpréter les résultats obtenus. Les résultats de ces premières essais, même avec leurs défauts, peuvent être considérer comme d'être des confirmations d'observations obtenues en 1934 qui disaient que des ananas de bon qualité puissent être cultivé et vendu au Ghana. Le développement accroissant de ce secteur, surtout dans la dernière décennie, a confirmé ceci. Ce que reste à faire maintenant est de promouvoir la base de la capabilité de la recherche adaptive et de bien financer la recherche afin qu'il puisse bien supporter et aider la transformation du secteur paysan à une entreprise agricole moderne. L'importance de la recherche et le financement dans la production d'ananas sont discutés dans la lumière des résultats qui sont rapportés ici.

Introduction

The history of crop improvement in Ghana started with the establishment of the Aburi Botanical Gardens in 1980 by a German carpenter working under a Lutheran Missionary (Agble, 1978). The botanical garden later in the same year became the erstwhile Department of Agriculture which became the focus of first organized effort in crop improvement. The Department established several research stations in selected ecological zones of the country for evaluating crops such as millet, sorghum, yam, rice, oil palm, plantain and banana, coconut and pine-apple.

Pineapple was particularly important in the Western Region formally known as the Western Province. Shipments were made from the Province to England between 1933 and 1934 (Anon., 1937). Reaction to the first shipments by a firm of fruit merchants in England indicated that there was no possibility of successfully marketing Ghanaian pineaple in England because of their unattractive colour compared with those from Azores.

On September 5, 1934, the future of the whole industry was discussed by the Ahanta (Sekondi-Dixcove) Agricultural Committee which passed the following resolutions. "The Committee considered that investigations should be conducted without delay by the Department of Agriculture to enquire into the possibility of producing marketable pines (pineapples) in the Western Province" (Anon., 1934). This historic decision may aptly be describe as the *dies natalis* of the pineapple industry in Ghana. The industry, however, passed through several generations before reaching its present level of development. Trials were first carried out on the following stations considered to be the best suited for the crop: Pokuase, Ohawu, Mampong-Ashanti and Wenchi.

Review of Trial at Four Stations

Pokuase Agricultural Station

The Pokuase Station is situated about 21 km from Accra on the Accra-Nsawam trunk road. It occupies an area of about 215 ha and was acquired outright in 1947.

The goelogy, topography and soils have been described by Will (1962). The vegetation is typically savanna grassland with thicket patches near the coast, passing through a thicket belt (quite wide in lower Densu basin but very narrow on the Accra Plains) to forest on the northern fringe of the area. Large portions of the area at the time of acquisition was secondary forest, which has since been cleared in most areas. The station falls between the 750 and 1000 mm isohytes (Ussher, 1969).

Pineapple was perhaps the most important cash crop in the Pokuase area and has remained as such till this day. Fresh pineapples, even in those days, commanded good prices in retail. The crop grows well between Pokuase and Nsawam under rainfed conditions even though climatically the area falls outside the limits for best exploitation of pineapple (Samson, 1982).

Most of the research efforts on the station between 1949 and 1962 were focused on the use of herbicides and mulches to reduce labour. The most important investigations conducted on the crop are discussed.

Longevity and yield trial 1949

The trial aimed at finding the number of ratoon crops that could be harvested in the Smooth Cayenne cultivar of pineapple.

Plants were spaced at 1.2 m × 1.2 m with a plant population of approximately 6800 plants/ha. Weeds were controlled by regular slashing.

Fruits were first harvested 12 months after planting and yearly thereafter from 1950 to 1957.

Results and discussion. The results showed a sharp decrease in mean fruit weight from the plant crop to the 3rd ratoon (1953/54). By the time the 6th ratoon was taken in 1956/57, mean fruit weight had decreased to less than half that of the plant crop (3.4 kg).

At the end of the 7th year of production, most of the plants died and weeds overgrew the remaining ones. Cost of production from the initial clearing to the final harvest, 7 years after, was carefully compiled and the returns computed. Cost of production including initial land clearing was esti-

mated from 1949 to 1958 at £G1300/ha. The overall profit margin calculated at 92 per cent fruit recovery over the seven-year period (1949-1955), amounted to about £G850/ha.

The profitability of the pineapple enterprise then was due mainly to the fact that labour cost were low, but even then it was realized that cutlass and hoe pineapple cultivation was labour-intensive and if chemical weed control methods were used, the profit margin could be increased.

Presumably, pineapple was cultivated for the first time in the experimental area and this could account for the longevity of the ratoon crops taken. The very wide spacing adopted also allowed enough area per plant to exploit soil nutrients. The rapid decline in the mean fruit weight from the 3rd ratoon would seem to indicate that ratooning was partly responsible. Other factors such as irregular and difficulty in weeding, no fertilization and, perhaps, root destruction contributed to the rapid decline in yield.

Mechanical vs chemical control of weeds in pineapple

The trial was designed to compare four different methods of weed control in the production of Smooth Cayenne pineapple for processing.

Treatments. Treatments applied were:

A - Hand hoeing with deep digging action

B - Light hand hoeing

C - Slashing

D - Chemical weed control.

Planting arrangement. Each treatment occupied an area of 0.6 ha and contained approximately 130 00 plants. Plants were spaced 60 cm between rows spaced 90 cm apart. Spacing within the row was 45 cm. Ten double rows constituted a treatment giving a plant population of 25000 plants/ha. The experimental design was not stated nor was there any indication that treatments were replicated.

The chemicals used for weed control were: Santrobrite (pentachlorophenol) applied at 22.5 and 33.6 kg/ha; Karmex W (Diuron) at 2.2 kg/ha and Marmex at the rate of 23.5 kg/ha.

It is not known whether the herbicides were applied in the plots.

Results. Results of the trial showed that none of the chemicals gave satisfactory weed control at the rates applied and Karmex at 2.2 kg/ha scorched pineapple leaves. Fruit yield data are shown in Table 1.

Discussion. The weaknesses of the trial were poor experimental design, absence of any replication and the very complex nature of the trial itself. It also seemed that the superimposition of flower induction treatment later was not planned initially and hence was arbitrarily done. It is not clear from the experimental procedure whether all the three chemicals were applied, how they were applied or if it was only Phyomone which was used.

TABLE 1

Fruit Yields and Mean Fruit Weights of Smooth Cayenne Pineapple Obtained Using Different Methods of Weed Control

Treatment	*Total number of fruits harvested*	*Fruit yield (t/ha)*	*Mean fruit weight (kg)*
Deep hand hoeing (A)	8,773	24.6	1.7
Light hand hoeing (B)	11,788	35.0	1.8
Slashing (C)	5,212	18.2	1.8
Chemical weed Control (D)	2,136	6.5	1.8

Diuron (Karmex) is widely used for weed control in pineapple especially when mixed with Bromacil. Moreover, Karmex is a wettable powder and should not have been sprinkled on the plots. The method of application of Karmex was suspect. It is also not known whether Marmex was a recommended chemical for use in pineapple or whether it was correctly used at the recommended rate. The author could also not find the listing of Marmex in a modern pesticide manual. It is likely that the chemical is no longer manufactured or is now listed under a different trade name. Plant arrangement in the plots, however, generally conformed to modern recom-

mendations.

From the mean yield results, light hand hoeing gave the highest fruit yield followed by deep hand hoeing and then slashing. Pineapple has shallow and limited root system and in the soil the roots rarely penetrate deeper than 30 cm (Samson, 1982). It would appear, therefore, that with light hand hoeing, only very little disturbance and damage was done to the roots to reduce plant growth and production. Even with deep hand hoeing, it is doubtful if a depth of more than 10 cm could have been reached. Compared with light hoeing, deep hoeing probably impaired nutrient uptake due to root damage and reduced plant stand and yield. Slashing, no doubt, was not thoroughly and efficiently done, a situation which could result in severe weed competition with the plants to retard growth and development thus resulting in poorer yield compared with light and deep hoeing.

Results of the chemical weed control clearly showed that the chemicals used failed to effectively control the weeds.

Mean fruit weights were, however, ideal at the time for export as grade AA (Ghana Standards) provided internal quality was good.

More useful information could have been obtained from the trial if proper attention was paid to the design and chemical application procedures.

Further investigation into the control of weeds in pineapple

Following the inconclusive results obtained in the earlier trial, a fruther trial aimed at determining an economic method of weed control was initiated in 1959. Treatments were arranged in a randomized complete block design with six replications but were not structured for statistical analysis of results. Details of the trial are in Table 2.

Herbicide treatments were each applied at low, medium and high levels in 50 m^2 sub-plots.

Smooth Cayenne suckers were set in the field on September 25, 1959 but no special planting arangement was mentioned.

Herbicides were applied at three rates as shown in Table 3.

TABLE 2

Herbicide Treatments and Plot Sizes in the 1959 Weed Control Trial

Treatments	*Plot size (m^2)*
1. Hand weeding	330
2. Mechanical cultivation	330
3. Thick leaf mulch	330
4. a. Brown paper cover	160
b. No weeding (control)	160
5. a. 2, 4 - D (2, 4 - Dichlorophenoxy acetate acid)	160
b. T.C.A. (Sodium salt of Trichloro acetic acid)	160
6. a. C.M.U. (Carboxymethylurea)	160
b. Simazine	160

TABLE 3

Rates of Herbicide Application to smooth Cayenne (1959)

Herbicide	*Low rate (ai/ha)*	*Medium rate (ai/ha)*	*High rate (ai/ha)*
2, 4 - D	2.5 litres	3.6 litres	5 litres
C.M.U.	5.7 kg	7.1 kg	8.5 kg
T.C.A.	5.7 kg	7.1 kg	8.5 kg
Simazine	5.7 kg	11.3 kg	17.0 kg

Harvesting. Harvesting was spread over 15 months from November 1960 to February 1962 and the results compiled and tabulated.

Discussion. The main criticism of the experiment is that it was planned without consideration for statistical analysis of the results. For this reason, treatment comparisons could be misleading due to partly structured and unstructured nature of the treatments. Treatments 4 to 6 (Brown paper mulch through Simazine application) *per se* were, however, structured in a way that they could be analysed as factorial or split plot designs. Statistical analysis

of the entire results was made more complex by the fact that each herbicide was applied at three rates in sub-plots and the problem of interaction between treatments could, therefore, not be ruled out. Hand weeding, mechanical cultivation, leaf mulch, brown paper cover and no weeding control could have been analysed as a randomized complete block design if the experiment was so planned. Herbicide treatments could also have been compared separately.

Much useful information could have been obtained if the experiment was properly structured for statistical analysis of the results; because of the way the trial was planned and run, any assessment of treatment effects can only be made on observations of the mean effects and by empirical deductions.

The mean effects on weed control showed that the leaf and paper mulch treatments gave the highest fruit yields and mean fruit weights.

Weed control was reported good and economically acceptable in these treatments. Generally, the low rate herbicide treatments also gave high yields. Simazine is recommended to be used at the rate of 3.2 - 64 kg/ha a.i. (Makhteshim-Agan, 1972). The 5.7 kg/ha a.i. rate used in the experiment was, therefore, within the acceptable pre-emergence rate recommended which should normally have been followed by a top-up treatment. The experimental procedure adopted was, unfortunately, silent on this aspect. It seemed most probable that this treatment was applied only once or the rate was low and less persistent under Ghanaian conditions; hence the vigorous weed growth barely a few months after the application.

It was also observed that with high rate herbicide treatments weed control was excellent but plants were stunted and, therefore, gave the lowest yields. Symptoms were especially pronounced in the C.M.U. plots. It was possible that the threshold rates of the herbicides for crop safety were exceeded. If crop tolerance ratings had been recorded, the extent of phytotoxicity could have been better assessed.

Though the results could not be statistically analysed, the following general observations can be made. Mulch treatments are beneficial to pineapple growth, development and high fruit yield. Chemical weed control in pineapple is possible provided the methods of application and rates are appropriate. Research results from pineapple growing countries have clearly indicated that chemical weed control is the best answer to successful pineapple cultivation (Py, Lacoeuilhe & Teisson, 1987; Samson, 1982). Research efforts should address these shortcomings of the pioneering efforts.

Ohawu Agricultural Station

The Ohawu Agricultural Station is situated 8 km north of Abor less than 1 km from the Ohawu village and 11 km from Tadzewu. It is 50 km from the Tefle ferry and 70 km from Keta.

The station occupies an area of approximately 358 ha and was acquired in 1955. Purnell (1956) has given a detailed description of the station including climate and vegetation, soil and soil series found in the area; these aspects, therefore, need no further elaboration. The station lies generally within the 1000 mm isohyte zone (Ussher, 1969). The actual rainfall figures, taken over a 10-year period at Dzodze, which lies approximately in the same rainfall belt as Ohawu, puts the mean annual rainfall at 1050 mm. The general vegetation is coastal savanna, varying closely with the different soil types.

Pineapple investigation 1958-60

Manser (1962) reported a trial of Smooth Cayenne and Sugar loaf pineapple cvs on the station from 1958-60. Details of the trial are, however, not available.

Discussion. Not much information can be obtained from the trial. Information necessary to assess the trial is entirely missing and the accuracy of the yield figures is also questionable, indicating that the records were not accurately taken. The trial also lacked an objective; a serious omission, which would seem to indicate that the trial was not structured for an assessment of the results. The yield of

1.0 t/ha fruit from the Smooth Cayenne plot in 1958, the year of planting, indicates in light of modern pineapple culture that very large planting materials capable of fruiting in the same year of planting were used. The plants flowered and their fruits matured within the same year. Slips were probably used in the Sugar Loaf plot. Fruiting, therefore, occurred after a year's growth. The investigation aimed at observing the growth and development of the cultivars.

From the point of view of minimum requirement in terms of rainfall, the planting could only be said to confirm that the crop could be grown in the area. However, from the rainfall distribution information given by Purnell (1956), pineapple plants would suffer very severe drought conditions in bad years, a situation which could lead to total crop failure in such years.

Information now available on the best climatic conditions for establishing a commercially viable pineapple business indicates that the rainfall distribution at Ohawu is too erratic for a successful venture unless irrigation can be provided and even then other conditions would make such a venture futile.

Mampong Ashanti Agricultural Station

Land for the establishment of the Mampong Agricultural Station was obtained through an agreement between the Local Authorities and the erstwhile Department of Agriculture.

A plot of land was, accordingly, allocated to the Department near Mampong on the Nsuta road in 1944. The area of land was subsequently increased to a total of 176 ha in 1959 (Miller, 1962). Adu & Jungerius (1960) carried out a survey of the area in 1959 and have provided full details of the location, climate, geology, relief, drainage, vegetation and land-use, soils and the soil series and, therefore, these aspects need no further emphasis except for the rainfall pattern which relates directly to pineapple culture. Mampong is characterized by a bimodal type of rainfall. The wet season normally lasts from the end of March to October but is interrupted by a well marked short dry season in July/August. The mean annual rainfall for 30 years was 1418 mm. Ejura, 40 km to the north of Kumasi, 58 km to the south and the station all lie between the 1375 and 1500 mm isohytes (Ussher, 1969).

The Mampong station is climatically suitable for the development of pineapple industry. The four month (November-March) dry spell is likely to limit optimum productive development of the crop, especially if the fruit matures in these months.

Pineapple investigations 1950-1956

The station was established for the purpose of Irish potato production and the investigation of related problems (Miller, 1962). However, pineapple investigations were conducted between 1950 and 1956 involving Smooth Cayenne, Queen and a third cultivar, 'Brazil' probably Abacaxi or Pernambuco which is extensively cultivated in Brazil (Samuels, 1970).

The aim of the investigations were to compare the growth, yield, fruit size and age of planting material under four manurial regimes. Four trials in all were conducted but only the results of the manurial investigation are reported here.

A 4 × 4 Latin Square design was used with plants spaced 90 cm × 90 cm triangular. No other experimental details are available and it is not clear if the same design was used for the other trials. Treatments in the manurial trial were:

(1) Sulphate of ammonia at the rate of 134.5 kg/ha applied annually.
(2) Farm Yard Manure (FYM) at the rate of 76 t/ha.
(3) Treatments 1 + 2 combination applied/ha in their entiety.
(4) Control (No fertilizer and no manure).

The mean yields of pineapple under the four manurial treatments are presented in Table 4

Discussion. In the first two trials, growth, yield and mean fruit weights of Smooth Cayenne and Queen cultivars were to be compared but fruits harvested were not recorded. However, the converted yields for the cultivars were recorded. It is, therefore, impossible to determine mean fruit weights of the different cultivars and make comparisons in

TABLE 4

Mean Yields of Pinneeapple under four Manurial Regimes (1953-19956)

Treatment	*Fruit yield (t/ha)*
Sulphate of ammonia	19.3
FYM	30.7
Sulphate of ammonia + F.Y.M.	32.0
Control	24.6

line with stated aims. Plant spacing was also too large although the stagger planting system enhanced light interception and utilization by the leaves. The large plant spacing gave very low planting density which contributed, in large measure, to low fruit yields and, therefore, under utilization of available land. There was also no indication of plant size used in the trials as indicated in the objective. The trial design was not sufficiently detailed to enable statistical analysis of the results for the separation of treatment effects. Comparative growth performances of the cultivars were not given.

Details of comparative yields of Smooth Cayenne, Queen and 'Brazil' were also omitted thus making meaningful and conclusive assessment difficult.

The 4 × 4 Latin Square tiral was also not sufficiently detailed to enable statistical analysis of the results to be made. The mean yields could, therefore, be misleading. It is difficult to understand why the application of sulphate of ammonia depressed yield compared with control but since no details of crop growth performance were given and since no information is available on how the experiment was run, it is difficult to explain the decrease in yield due to sulphate of ammonia application.

It is obvious from the mean yields, however, that addition of sulphate of ammonia to FYM had a slight beneficial effect on fruit yield, compared with FYM alone. The manurial trial has, however, given an indication of the beneficial use of FYM in pineapple cultivation. Optimum levels and effects on fruit quality need to be investigated further.

Wenchi Agricultural Station

The Wenchi Agricultural Station was formally acquired in 1953 but development started in early 1962 (Miller, 1962). A full soil survey of the area was carried out in 1958 by Stobbs (1959) in which details of climate, geology, topography, water resources, vegetation, soils and soil series are included.

Torto (1950) described the vegetation of the area as savanna forest and the rainfall pattern as bimodal separated by a dry rather prolonged season. Wenchi lies between the 1250 mm and 1375 mm isohytes with 30-year mean annual rainfall of 1290 mm (Ussher, 1969).

Pineapple investigations 1954-1957

Pineapple trials were conducted on the station between 1954 and 1957 on `Black Antigua' and Smooth Cayenne pineapple cultivars to determine the relative yields and mean fruit weights.

In the first trial planted in 1954, plants were spaced 1.2 m apart on 75 cm wide ridges with farm yard manure applied in the furrows in 0.2 ha plots. The amount of FYM applied was not indicated.

Fruit yield taken in 1956 was very low (8.3 t/ha) with mean fruit weight of 1.8 kg.

A second trial was planted in 1957 and involved two pineapple cultivars Black Antigua and Smooth Cayenne. Plants were spaced in double rows 60 cm on beds 1.5 m apart. Liberal amounts of FYM were applied but the time of application and the amounts applied were not stated.

Black Antigua was planted on 840 m^2 while Smooth Cayenne occupied 600 m^2 area. Results of this trial were very conflicting.

Discussion. Not much confidence can be placed in the results of the trials since they were planned and executed without regard for statistical analysis of the data.

In the case of the application of FYM, it would have been useful if the amounts applied had been stated and the trial planned to compare FYM and the control. The yields recorded for Black Antigua in 1958 and 1959 are suspect compared with those

for the same cultivars in 1955 and 1956 even though liberal amounts of FYM were applied. Even if climatic conditions in 1958 and 1959 favoured increased yield, it is very doubtful if nine-fold increase could have been obtained with no recorded improvement in culture or treatments applied. It is more likely records were not accurately kept.

The value of the results of the trials lies in the realization that pineapple can be grown under the climatic and soil conditions at Wenchi. Well-planned and executed trials need to be carried out to determine the pineapple potential for the area.

Conclusion

In response to the historic resolution of the Ahanta Agricultural Committee of 1934, the Department of Agriculture made attempts to determine the adaptability of various cultivars of pineapple for eventual cultivation in Ghana. The development of the industry since that time and especially within the past 15 years has proved that Ghana can indeed produce marketable pineapples for export.

Even though the enterprise has not yet developed into a full-fledged industry, there is every indication that with more research, dedication, application of appropriate technology and capital funding, Ghana can compete favourably with other pineapple-producing countries in West Africa.

Information gathered from the numerous reports available indicated that the pioneering investigations were concentrated on stations where the ecology seemed favourable to the cultivation of the crop. The selection of Pokuase, Ohawu, Mampong-Ashanti and Wenchi stations was, no doubt, carefully considered in terms of possible climate and soil suitability for exploratory work. However, the trials were not designed for statistical analysis of the data to enable better interpretation of the findings to be made.

Considering the trials conducted in response to the Ahanta Agricultural Committee resolution, one can draw certain conclusions from the investigations.

There were attempts to determine the comparative merits of Smooth Cayenne, Queen, Brazil and Black Antigua cultivars through introductions, test plantings and compilation of relative yield data and the drawing of empirical conclusions from the results obtained. Attempts were also made on some stations to determine the ratooning capacity of the cultivars and relate this information to production cost and returns on investment. Introduction and evaluation of new germplasm still stand out as springboard in plant improvement today.

The Queen cultivar performed well at test sites and it is also a good shipper as fresh fruit (Samuels, 1970). At the moment, only few plants of the Queen cultivar can be found in obscure areas of the country. Since Ghana is interested in the fresh fruit export market, it will be worthwhile to reintroduce this and other similar suitable cultivars for screening. In April 1989, one of the leading pineapple producers told the author that he was teaming up with his counterpart in Cote d'Ivoire to explore the possibility of producing the Queen cultivar for export (Koranteng, Personal communication).

These early trials also recognized the high cost of pineapple production by the cutlass and hoe method of weed control and attempted to reduce production cost by the use of mulches and herbicides. Results of the ivestigations at Pokuase revealed the beneficial effects of mulching in controlling weeds in pineapple. Even though no difinite conclusions could be drawn from work with herbicides, the indications were that they could offer an effective way to economic weed control. Today, the use of very selective herbicides for the control of weeds in the cultivation of pineapple has become an established practice in all pineapple growing countries and also on most farms in Ghana.

Attempts were also made to determine the effects of sulphate of ammonia and FYM on the growth and yield of pineapple. In the light of what is known today, the conclusion drawn from the use of sulphate of ammonia were surprising. It is not unreasonable to think that procedures adopted for the application were faulty since the scientists themselves were perhaps not very conversant with the physiology of the crop.

The ultimate goal of a producer is to put on the

market a product that is competitive with those from elsewhere. These early trials also took cognisance of this fact and on one station an attempt was made to determine the cost of production of pineapple and compare this with income to determine the profitability of returns on investment. Since then, the economic situation the world over has changed considerably but the rationale for information on profitability will always remain a crucial factor in deciding pineapple enterprise. For this reason, more and more agreements, on agricultural projects especially, are insisting on the inclusion of economists on the research staff component.

There is an urgent need to concentrate research efforts on areas such as fertilization, weed control, uniform flower induction, pest and disease control, production technology, improvement in port infrastructure and refrigerated shipment trade (because of rising airfreight charges), careful handling, consistent quality and selection control, suitable packaging and coordination of transport operation to ensure maximum returns on exports.

The feasibility of the production of pineapple juice concentrate at glut periods of the year should also be explored to expand the export base of the industry in future.

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