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Department of Agriculture, Stock and Fisheries,
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R. M. BOURKE.

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The Wildfowl Egg-Grounds of West New Britain

M. C. DOWNES, Chief, Wildlife Section

Wildlife ecologists have become concerned that the wildfowl egg-grounds in the Nakanai area (Cape Hoskins) of New Britain are in danger of disappearing. Large tracts of timber rights have been sold and as lowland rainforest is the birds' natural habitat, the wildfowl may well disappear and with them an important social and economic resource of the Nakanai people.

Not many people know about New Britain's thermal spring and solfatara areas. They are desolate places of hot springs, geysers and deep holes which reverberate to the sound of boiling mud. Forest grows right to the edge of the hot areas and there is a nauseous smell of sulphur. It is the strong sulphur fumes which inhibit growth in the immediate areas. There are three main solfatara areas in New Britain: smallish ones at Matupit (Rabaul) and Garu (Talasea) and a large one near to the Kapiura River about 20 miles from the Government station of Hoskins (*Figure* 1).

Plate I.—Hot springs area in New Britain

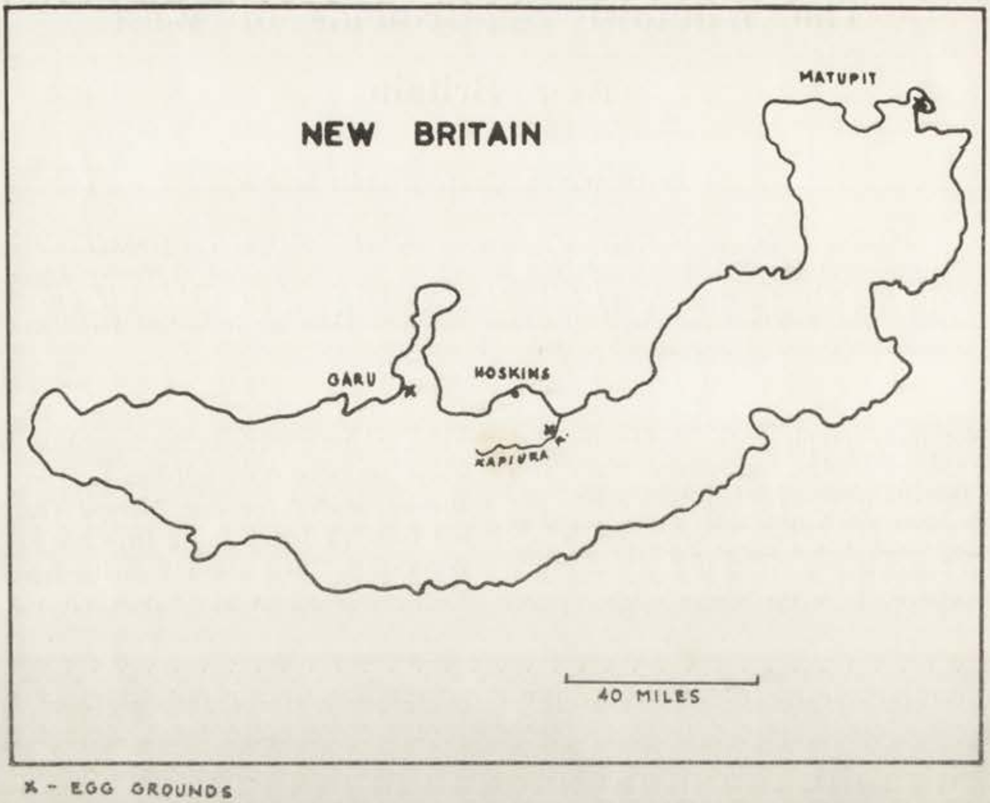

Figure 1.—Location of wildfowl egg-grounds

The bird, *Megapodius freycinet*, which we call the wildfowl, has utilized these hot areas for the purposes of incubating her eggs. In most other places the Megapodes build mounds of earth and leaves which decay, giving off enough heat to incubate their eggs. In the Nakanai area, the wildfowl burrow into the warm sands at just the right distance from the hot springs to give the correct incubating temperatures.

The birds fly considerable distances to the thermal area during the laying season, which coincides with the dry season—April to November. The hen burrows deep into the warm ground beneath the forest trees and amongst the roots and lays her eggs at the end of the hole—about 4 ft from the ground surface. There are usually six or seven such tunnels close together and the fowl may lay up to ten eggs in each. When she has laid her eggs, she fills up the tunnel again and usually only those who are expert can tell where the tunnels are. The hen has no further part to play in the care of the chickens.

After 6 to 9 weeks, the chicken will hatch out of the egg, and scratch its way to the surface using its large feet (hence the name Megapode). The chick is well developed at birth, covered with feathers and able to fly. It is able to feed and protect itself from the time of emergence from its tunnel.

Generally the wildfowl have similar habits to the domestic hen. They scratch for food, are able to make short flights out of danger and roost on low branches at night. They do not appear to have any sexual displays or display areas and are thought to copulate near the hot areas where the eggs are laid. Not much is known of sex differentiation nor of nesting habits. Their food consists of seeds, small fruits, insects and worms.

The people from nearby villages and some distant villages have gathered eggs for at least 100 years. The ownership of the egg-grounds has been jealously guarded, subject to tribal law and custom and has formed an intricate part of village economy and politics. Seri-

Plate II.—*Megapodius freycinet,* the wildfowl

ous fighting and deaths are still remembered by the older people as results of disputes over egg-grounds.

Indiviual egg gatherers can collect 40 to 80 eggs in 1 day and at times over 50 people can be seen working over the burrows. An experienced digger can tell by the appearance of the surface sand which of the many holes are likely to contain eggs. They dig down—often head first—until sometimes completely out of sight, following the ramifications of the burrows. Women, rather than men, make such forays underground in the Nakanai.

Detailed study of the egg-grounds will be needed to measure present and potential production. It has been estimated that over 2,000 eggs have been consumed at one village sing-sing. There are indications of average minimum monthly collections of 5,000 eggs. Records for the whole of the 1971 egg-laying season indicate roughly 15,000 eggs were harvested at each of the Pokili and Garu egg-grounds. At a local price in Hoskins of 3 for 10c, the eggs can be seen as a valuable resource for the people.

All known egg-grounds are subdivided for egg rights, with ultimate authority resting with particular village leaders or communal authority regarded as owning the land. These men regulate the egg collecting by both their own clans and the clans of other villages. Such leaders as Boas of Galilo village and Lima and Tomagu of Koimumu village (these villages having the largest undisputed rights within the Nakanai egg-grounds) are becoming increasingly concerned by diminishing supplies of eggs. They can point to areas which 30 years ago had huge supplies, which have now dwindled to nothing. This decline in supplies could be due to a number of things, not least of them being over consumption of eggs. Other factors could be prolonged disturbance of egg-grounds (e.g. one large egg-ground used to be very near a village); alterations in volcanic activities causing different ground temperatures; and logging activities. As far as overcollection and disturbance goes, the local leaders have taken firm steps to help conservation. They have determined who may take eggs and on which day or week they may do so. Neither adult birds nor chicks leaving burrows may be killed. No picnicking, shooting or other village activities are permitted on or near the egg-grounds. To add weight to these village laws, the people are trying to get their Local Government Council to adopt the rules and to impose penalties when the rules are broken.

An immediate problem will be to ensure the protection of the forest area for at least 5 miles around the egg-grounds as the forest is vital for feeding and sheltering the wildfowl. Timber rights have been sold in great quantities all about the Hoskins-Kapiura area. Attempts to 'take away' the egg-grounds and hot springs area from the people in order to 'preserve' its special features would be self-defeating. Likewise attempts to buy the egg-lands would be so complicated and fraught with ownership claims as to prove impractical. In short, any plans for the management of the Nakanai egg-grounds must be designed as an operation of the people by the people (with guidance) and on their own traditional land.

Plate III.—Egg-grounds among forest trees

Pineapple Production in the Markham Valley

M. N. HUNTER, Agronomist and B. SICKEY, Experimentalist,
Bubia Agricultural Experiment Station

The cultivated pineapple (Ananas sativa) *is a well-known fruit throughout Papua New Guinea. Like a number of other fresh fruit crops, large scale commercial production is restricted by difficult export marketing problems.*

However, with the rapid increase in urban population at the major centres throughout the country, local market consumption is beginning to look attractive for small scale pineapple enterprises close to these major centres.

SOILS

Pineapples grow well on well-drained loams with a friable subsoil and ample organic matter. While they may prefer acid soil conditions, they also appear to thrive on alkaline soils. The plant has a very shallow rooting habit and is thus subject to nutrient stress, especially nitrogen in open soils that drain freely. This shallow rooting habit makes the plant susceptible to damage during cultivation, which should be kept to a minimum.

PLANTING MATERIAL

Four different types of vegetative material taken from the mother plant can be used in pineapple propagation. These include tops, slips, suckers and butts. Odd seeds are often found in fruit but propagation is slow and the plants do not breed true. Commercial use of seed is not possible.

Tops—This material is broken from the top of the ripe fruit at harvest, and while use of tops will give a uniform stand, use of tops is restricted to canning enterprises. In the marketing of fresh fruit the top is left on the fruit, and is thus not available for planting. After the tops are removed from the fruit the smaller leaves are removed so that about ¼ inch of the base of the stalk is exposed. This should be done while the top is still fresh as stripping becomes more difficult later on.

Slips.—These are offshoots from the fruit stalk (*Plate* I). As they are usually small, it is common practice to leave them on the parent plant as long as possible to increase in size. After collection the small pinelet at the base of the slip is broken off and slips stacked to dry. As with tops the basal leaves are pulled off to assist in early establishment of the root system after planting.

Suckers.—Suckers result from the development of the buds found in the axils of the lower leaves (*Plate* II). Suckers usually develop towards the end of the fruiting cycle, but rate of development can be quite variable. Grading is essential if uniformity is desired. Very large suckers are not always satisfactory since they are more susceptible to moisture stress. As with other material, it is desirable to strip the base to allow the ends to dry out.

Butts.—The butt is the stem of the mature plant and when cut up into small pieces and planted, it will shoot. The younger part of the butt germinates more readily. This method can only be recommended where there is a big demand for planting material since the plants so produced would take up to 2 years to produce fruit.

GRADING

It is desirable to grade all planting material with regard to size since non-uniform material will cause difficulties in crop management and give a crop of variable fruit size because of unequal competition between adjacent plants.

TIME OF PLANTING

Normally the time of planting is determined by the availability of planting material, which is dependent to some extent on time of fruit production. Thus, at present, planting would be carried out over the early new year period after suckers from plants that flowered in June had developed sufficiently. Tops would have been planted slightly earlier.

However, as will be discussed, time of crop production can be controlled and if the right vegetative material is available, successful planting can be carried out at any time.

Plate I.—Pineapple plant showing a slip growing out from the stem immediately below the mature fruit, and further down the stem a sucker growing out between the leaves

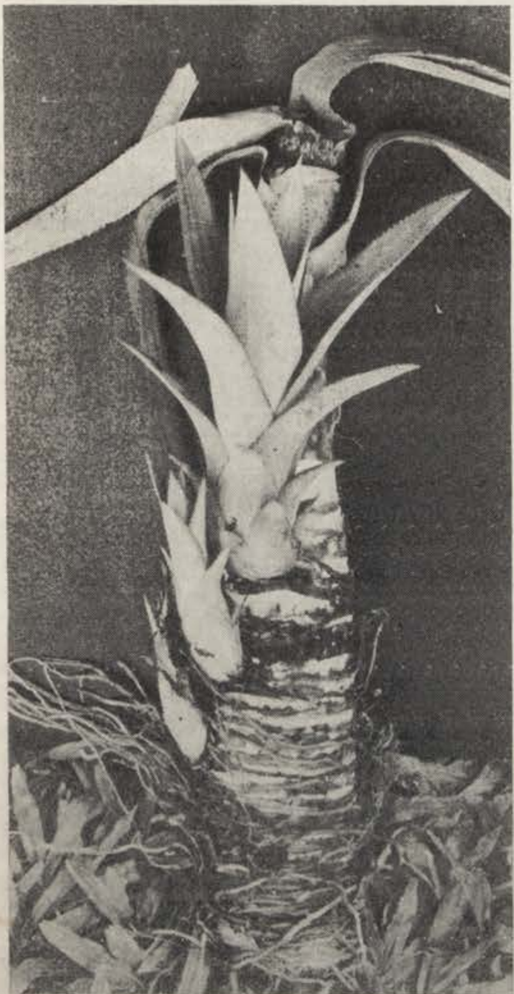

Plate II.—When the leaves at the base of the stem (the butt) are pulled off, several suckers may be seen. They may be pulled off and used as planting material. It is desirable however, that suckers of the same stage of development be planted together.

SPACING

At present planting techniques currently employed in Queensland are carried out at Bubia. This consists of 2 rows 1 ft apart with plants 1 ft apart in the row. Each double row is 6 ft apart from centre to centre, to give a plant population of approximately 14,500 plants per acre. Such spacing should lead to efficient land usage, but where land is not limited wider spacing may be used to allow easier maintenance, which does become difficult especially in ratoon crops.

FERTILIZATION

The plant food requirement of pineapples is high, bearing in mind that between 10 and 20 tons of fruit per acre can be removed per crop.

On an alluvial calcareous soil at the Bubia Agricultural Experiment Station in the Markham Valley, fruit production increased when nitrogen and potassium were added but not when phosphorus was added.

Nitrogen.—Leaves of pineapple plants deficient in nitrogen turned a reddish-orange colour and the lower leaves curled and dried off. Plants with adequate nitrogen ranged from a light green colour to a dark green colour with a purplish tinge. In one trial added nitrogen increased fruit size from 42 oz to 45 oz and per acre yield from 8.4 tons to 9 tons of fresh fruit. Based on 7,250 plants per acre.

Potassium.—When nitrogen was limiting the addition of potassium did not appear to affect fruit size but where nitrogen had been added the application of potassium further increased fruit size from 45 oz to 46¾ oz, equivalent to an increase of almost half a ton of fruit per acre. In addition fruit on potassium-treated plots were not so prone to leaning over (lodging), a condition which leads to fruit sunburn and distortion.

Nitrogen was added as ammonium sulphate at the rate of 350 lb of compound per acre and potassium as muriate of potash at 500 lb of compound per acre.

In the light of the apparent response of many crops in the Markham Valley to added sulphur, it is worth bearing in mind that some of the response in the nitrogen-treated plots may be due to the sulphur in ammonium sulphate.

With regard to use of fertilizers in pineapple production, split applications of fertilizers, especially easily leached ones such as nitrogen, are desirable. In porous soils where heavy rainfall is common, leaching can be considerable, with the result that the plant foods are washed out of the range of the root system. Addition of various forms of humus such as rotting plant material should appreciably reduce this loss.

FLOWERING

It appears that the flowering process in the rough leaf pineapple is affected by hours of daylight and unless chemically treated this variety will only flower consistently from mid year until December. After the first signs of flowering, which appears as a pink flush in the heart of the plant, fruit development takes a further 3½ months. Thus there is quite a long gap in the year when pineapples are very scarce if only natural flowering is relied upon.

Fortunately this plant is one of the very few plants that can be induced to flower by the addition of a chemical, in this case alpha napthalene acetic acid. By pouring the correct amount of this chemical (trade names: Phyomone or Shellestone) into the heart of the plant, flowering processes are initiated and within 5 or 6 weeks of the application the pink flush becomes evident.

This means that provided the right planting material is available fruit production can be organized on a regular basis. A current trial indicates that this induction may be made in as little as 10 weeks after planting out of medium-size suckers.

RIDGING

Ridging may be necessary where there is a chance of waterlogging and in a trial at Bubia, a comparison was made between ridged and unridged plots. Surprisingly it was shown that unridged plots gave fruit of 51 oz compared to 44½ oz in ridged plots, an increase of almost 1½ tons of fruit per acre. The ridges in this case were 2 ft wide, with the centre of each ridge 6 ft from the centre of the next ridge. The furrow in between was about 12 in deep. Suckers were planted 6 in from the shoulder of the ridge.

Besides having smaller fruit, ridged plants also leaned appreciably into the furrow, presumably through loss of support of the lower leaves on the furrow side. This leaning led to sunburn and fruit distortion. One reason for the big size difference may lie in the excessive leaching that would occur under the ridged conditions. Obviously ridging of this sort is not satisfactory and other methods of drainage should be considered.

SHADING

A common observation often made of pineapples is the much greener and healthier appearance of plants growing in the shade of trees when compared with adjacent plants under unshaded conditions.

A comparison was made between shading plots with hessian and leaving others unshaded. As expected shaded plants remained much greener, and they also produced fruit of an average weight of 57½ oz compared to 44½ oz of unshaded fruit, an increase of 2½ tons of fruit per acre. This obvious benefit may not have been so marked if nutrients were not limiting under the unshaded conditions. On the other hand, pineapples may prefer shaded conditions. However, the main conclusion is that pineapples can be grown successfully under shade. On the basis of this it may be possible to successfully interplant existing coconut groves with pineapples, in areas where market outlets exist.

RATOONING

In Australia pineapple plants are allowed to ratoon, normally twice. The original plant gives one fruit and a number of suckers. After harvesting, all suckers except one are removed. This sucker produces another fruit and more suckers. As before, after harvesting, only one sucker is left on this plant and allowed to produce fruit. After the third cropping (second ratoon crop) the area is ploughed out and replanted.

Successful ratooning depends on sucker production. No detailed work on the ratooning aspects of pineapples in Papua New Guinea has yet been carried out, but would warrant further investigation.

MARKETS

Regular pineapple production on a commercial scale to supply increasing urban populations could be an attractive proposition for a small number of enterprises adjacent to the main centres.

Large scale production may be possible if satisfactory arrangements could be made with New Zealand marketing organizations in backloading cold storage ships which transport fresh fruits and vegetables from New Zealand to this country.

Pineapple juice extraction for distribution throughout Papua New Guinea may also be feasible.

Barramundi Research in Papua New Guinea

L. F. REYNOLDS, Fisheries Biologist

There has been a progressive increase in the importance of fisheries in Papua New Guinea's development over the years. Prawns and barramundi have become the top seafood export earners representing $600,000 *and* $80,000 *respectively. Tuna will shortly replace these and will become the major export earner with the proliferation of the Japanese poling fleets around the New Guinea Islands.*

Commercial fishing for barramundi is carried out in the inshore waters and estuaries around Daru, and to a lesser extent in the Bensbach River (near the West Irian border) and Lake Murray. *Figure* 1 shows the distribution of barramundi in Papua New Guinea and the major fishing grounds and processing plants. There were 334,600 lb headed and gutted fish and 6,670 lb fillet exported from Daru in 1969 (equivalent to 445,600 lb of whole fish). In 1970 there were 142,019 lb headed and gutted and 73,178 lb fillet (equivalent to 295,640 lb of whole fish). At an average export price of 28c per lb headed and gutted and 50c fillet, this represents a total of $77,800 the export industry is worth. Most (90 per cent) of the fish are caught in salt water, these being the most desirable, and over 70 per cent are bought by expatriate freezer owners from local fishermen (usually at 40c per lb fillet).

This industry is important to the Western District of Papua as the majority of the Fly River basin is swamp and swamp forest, as yet undeveloped for agriculture. Fish and fish processing then represents the major cash income for the village people in these areas.

To determine the extent of the stocks, the biology and the maximum sustainable yield of barramundi, a research programme commenced in March, 1970. This programme involved a team of two biologists and 10 to 12 local research assistants. To date, effort has been concentrated on both a tagging programme and surveys of areas having at present non-commercial production of fish.

The tagging programme commenced in August, 1970 and since then some 5,000 fish have been tagged. Fish were tagged at Daru (4,000), Lake Murray (500), Fly River area (350) and Port Moresby (150). Most fish were tagged with opercular clip tags (Monel metal, individually numbered) although some 500 fish have been tagged with plastic dart tags. The *Plate* shows an opercular clip tag in position on a fish, although most of the small fish in this size range are given dart tags.

There has been an extensive publicity programme about the tagging, particularly in the Western District. This involved press and radio coverage, individual posters and a 50c reward for the return of tags. As a result of this, tag returns have been good, particularly from local fishermen, there being over 200 returns (4 per cent) from private and commercial fishermen. Recaptures during tagging amount to over 10 per cent (500), these being recorded and released again. Of the 500 recaptures, most are recaptured only once, although 1 fish has been recaptured five times.

Fish were collected for tagging using beach seine nets, and less extensively, 7 in gill nets. The size range for beach netted fish was 17 cm to 90 cm total length, although the majority of the fish fall into the 25 to 60 cm range. Gill nets are extremely selective and collect only fish in the range 60 cm to 100 cm. So far no fish under 17 cm have been found although a variety of techniques are being used. There is a distinct bimodality in length frequency data from gill nets, the females being the larger (mean 85 cm compared with 75 cm for males). Gill nets result in a high-mortality rate—at least 30 per cent of the fish are unsuitable for tagging, compared to less than 1 per cent for the beach net.

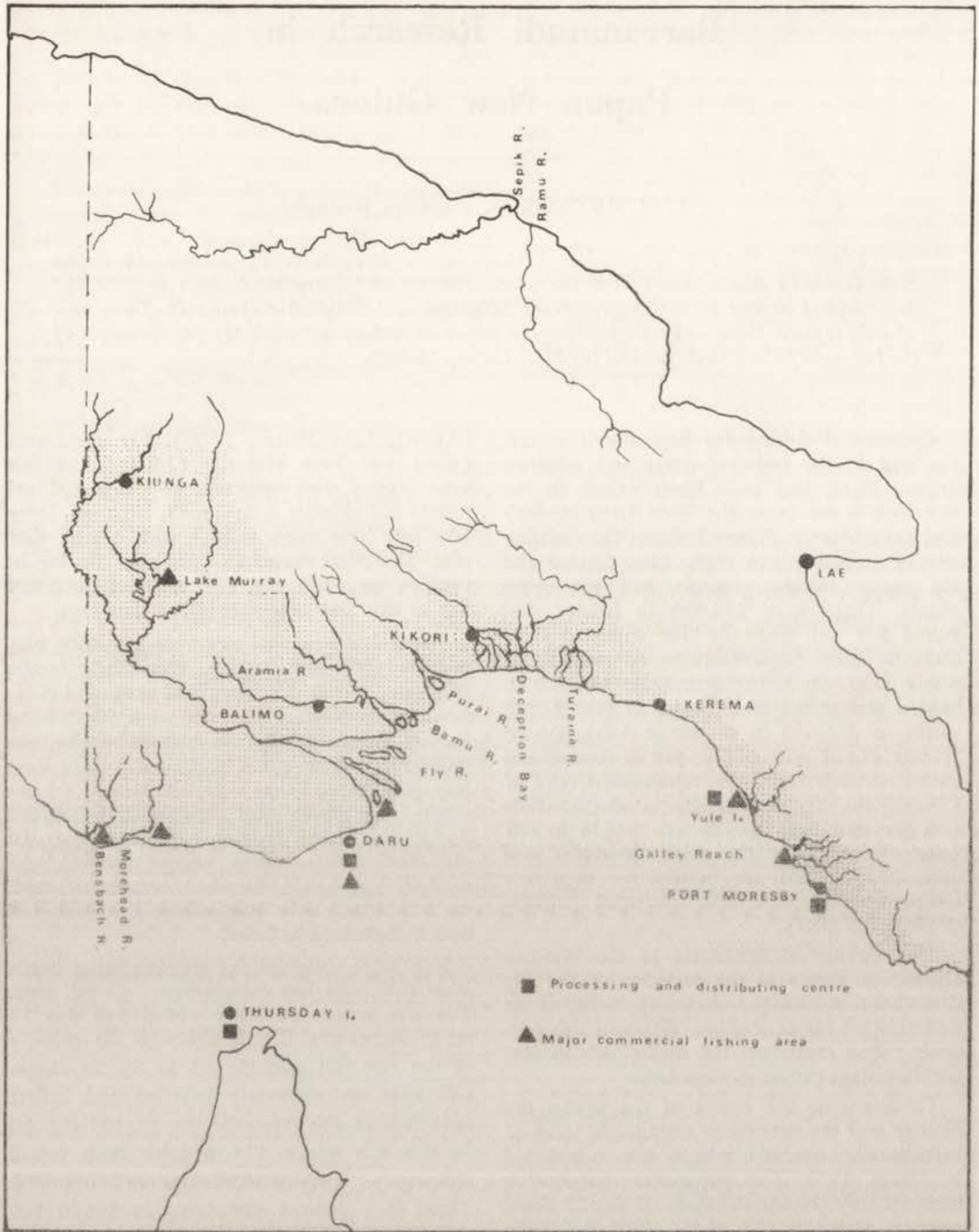

Figure 1.—Distribution of barramundi in Papua New Guinea

Plate 1.—Fish showing clip tag in position

Preliminary tag returns show a general pattern of movement (*Figure* 2). Prior to February, 1971 there were no long-range movements recorded, only short coastal movements around Daru. Since then tag recoveries have shown many upstream movements (*Table*). One fish was recorded as moving to Kikori, half-way across the Gulf of Papua. The return movement for breeding purposes has to date only been demonstrated by No. 4107 moving from the Upper Fly River (above Lake Bosset) to the Kiwai Islands in the Fly River estuary.

Further research is to be carried out over the next 3 years. A new 35 ft boat, suitable for river and estuarine work, is to be purchased as soon as possible. Surveys are to be extended, particularly to the underdeveloped Gulf District, and intensive tagging in this area will take place. One important facet of the work to be carried out in the future is the establishment of pond culture techniques for these fish, particularly in conjunction with the introduced rapid growing fish, *Talapia mossambica*, which can be used as a food source for the barramundi. A further extension of this will be an attempt to establish artificial breeding of fish in ponds to offer a source of eggs and fry for experimentation and limited distribution to fish ponds. With a source of supply of fingerlings, it should be possible to provide sport fish for closed waters (such as hydro-electric dams) which would normally not have barramundi because access to the salt water for breeding purposes is denied.

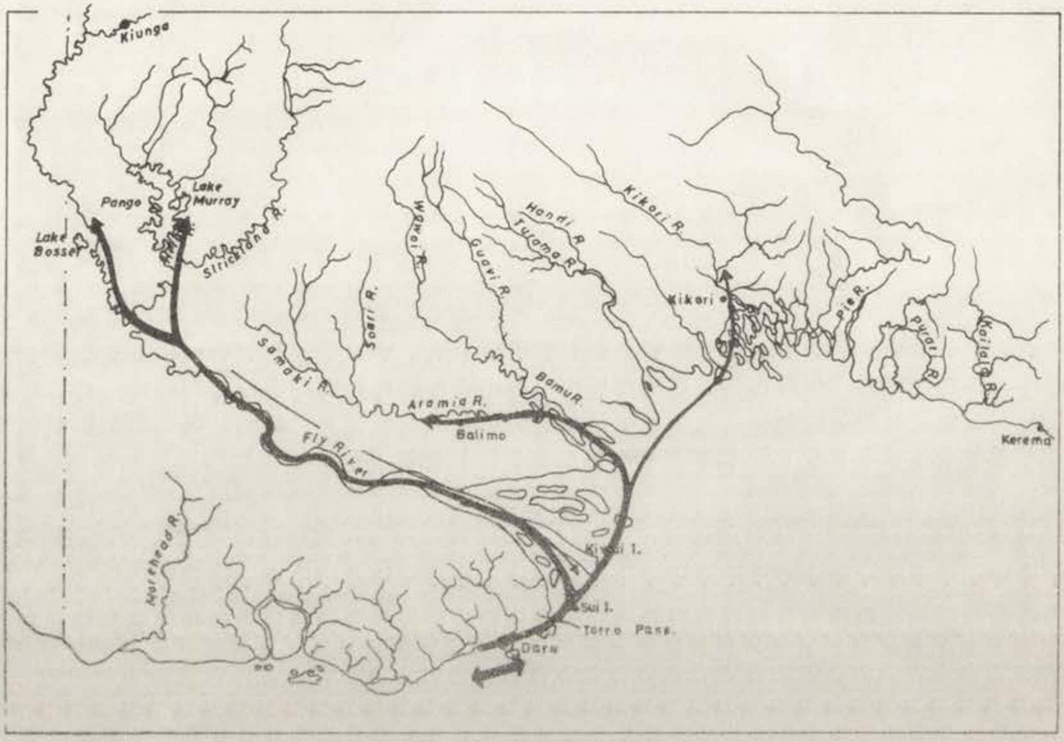

Figure 2.—Map showing general fish movements

Table.—Tag recaptures showing significant movements

Tag No.	Date Released	Place Released	Place Recaptured	Time at Liberty (Days)	Distance Moved (Miles)
557	6.10.1970	12 miles west of Daru	Lake Murray	358	370
852	11.11.1970	Sui village	Lake Murry	104	330
1247	8.12.1970	12 miles west of Daru	Junction of Bamu and Aramia River	120	160
2484	18.3.1971	12 miles west of Daru	Kiwai I.	90	49
15	18.3.1971	12 miles west of Daru	Kiwai I.	50	49
2682	29.3.1971	7 miles west of Daru	Kikori	51	270
2836	27.4.1971	12 miles west of Daru	Kiwai I.	50	49
2959	30.4.1971	Sui Village	Fly River-Strickland River Juncton	51	270
4107	19.9.1971	Lake Kongan (Upper Fly)	Kiwai I.	33	285

Cattle Yards

R. D. E. RANKIN, Regional Livestock Officer (Papua)

All too often people in this country start cattle projects in a small way giving no thought to the possibilities of future expansion. The tendency is to think small with the result that when the farmer wishes to expand his project, he forgets that the yards he put up for his 10 *head herd are now completely inadequate for his increased herd.*

With this in mind it is best when commencing a set of cattle yards for 10 *beasts to build them to a pattern which lends itself to expansion to* 40 *head and later, if necessary, to expansion to hold* 120 *head.*

A. SITING OF YARDS

1. *Drainage*

All yards must be constructed on well-drained land and never in low-lying wet areas.

2. *Position*

(*a*) Cattle yards must be built on a fence line and not in the middle of a paddock. In this way the fence acts as a wing which cattle follow when driven and provided gates into the yards are near the fence line, cattle will walk into the yards without much trouble (see *Figure* 1).

(*b*) The area must be large enough to allow for future extensions as the herd increases.

(*c*) The yards should be near to the centre of the total area so that all paddocks are accessible to the yards without having to drive the cattle further than necessary. If it is possible to extend the total area in the future, then this should be taken into consideration when choosing a site for yards.

(*d*) The yards should be close to an existing road to enable the loading and unloading of cattle into the yards and facilitate servicing of the project by officers of D.A.S.F.

3. *Shade and Water*

(*a*) Where possible, shade trees should be left and not cut down. Build the yard around the trees, leaving trees in the holding yards to give shade to the cattle. Trees should not be left in the *centre* of the fencing yard but can be left standing close to the fence. Never use trees as fence posts for the yards and always remove trees from gateways. If trees must be removed, peg out the yards first, then remove unwanted trees. It is best not to leave too

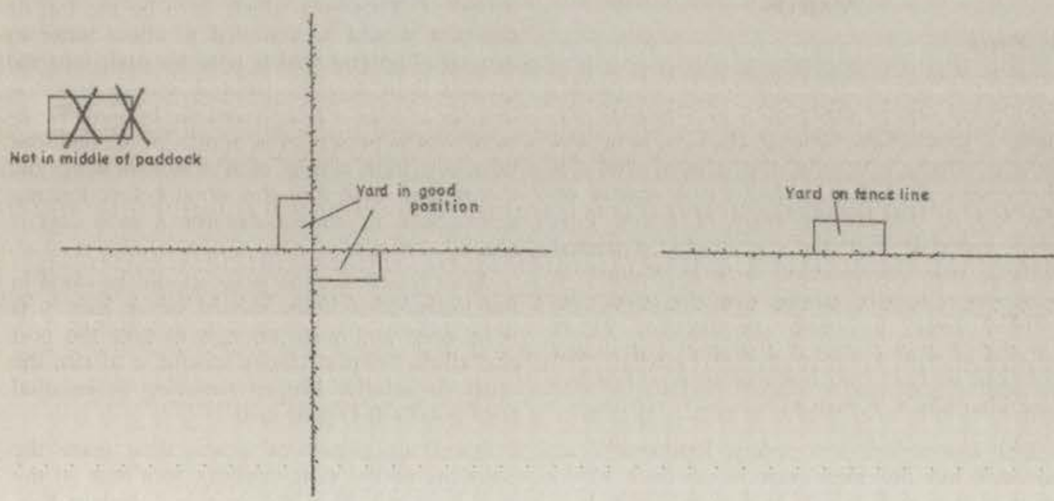

Figure 1.—Yard is built on an existing fence line many trees otherwise the sun will be unable to dry out the ground. If there are no trees around the yard site, then plant some. Make sure they are protected from trampling in the early stages by enclosing them inside a sturdy fence.

(*b*) Water is essential and should be available to animals held in the yards for any length of time. As well as for drinking, water is necessary for washing and also for the spraying of stock against cattle tick in tick-infested areas.

Build the yards if possible near a creek or river from which water can be easily got to the yards—either by pipe reticulation or by buckets.

4. *Small Holding Paddock*

A small holding paddock of 2 to 5 acres should be built on larger projects for holding animals for short periods. This paddock should be built adjoining the yards. It must include a permanent water supply (be it reticulated or a creek) and can also be used as a convenient place for sick animals (see *Figure* 2).

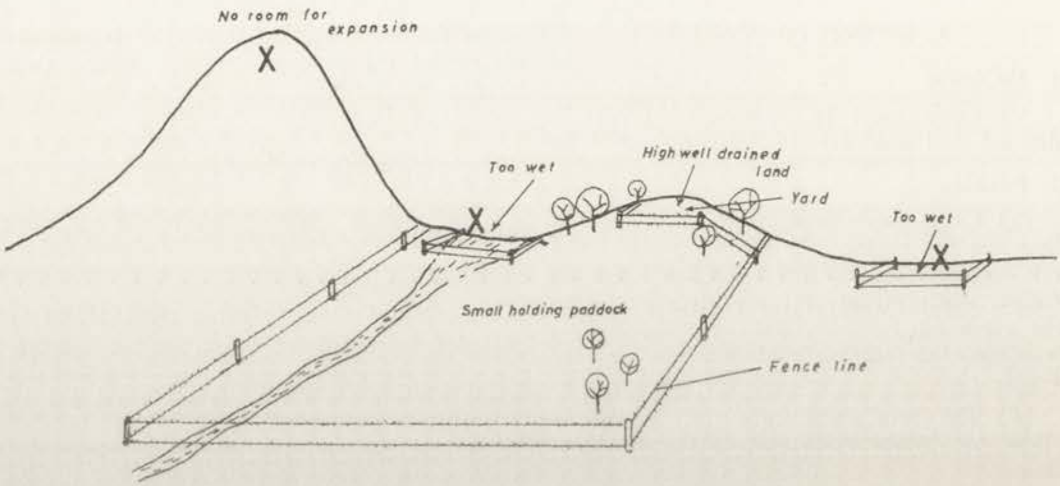

Figure 2.—Small holding paddock is built adjacent to yard

B. MATERIALS USED IN BUILDING YARDS

1. *Posts*

(*a*) *Galvanized iron pipes.*—Good permanent posts can be made of 3 in (internal diametre) pipes. Get them 9 ft 6 in long and cement them 3 ft into the ground and fill them with sand. Cap with 2 in of cement on the top to prevent the entry of water. Pipe posts, especially near the sea, should be painted with a rust preventative such as Kilrust at least once a year taking care to cover the welded areas. In crush construction, 21 ft lengths of 2 in (internal diameter) galvanized pipe can be bent into bows using pipe benders (see Plan No. 4, *Figure* 8).

(*b*) *Hardwood pots.*—Any hardwood can be used but the logs must be at least 12 in in diameter and 10 ft in length. Split logs and those of a smaller diameter must not be used. Logs are cut into the correct lengths and debarked. That end which is to be the top of the post should be rounded to allow water to run off. The end which is to be sunk into the ground must then be painted with a preservative for at least 4 ft up from the bottom. Treatment with preservative must be carried out three or four times, each time allowing the chemical to soak into the wood before treating again. Soaking once a day for 2 or 3 days is usually sufficient.

After treatment, the posts should be stood in the holes. Post holes should be at least 3 ft 6 in deep and wide enough to take the post and allow adequate room around it to ram the earth in solidly. Proper ramming is essential for a good solid set of yards.

Stand up a row of posts, then mark the positions of the rails, making sure that all the marks on all the posts are in a straight line. For distances between rails see Plan No. 4.

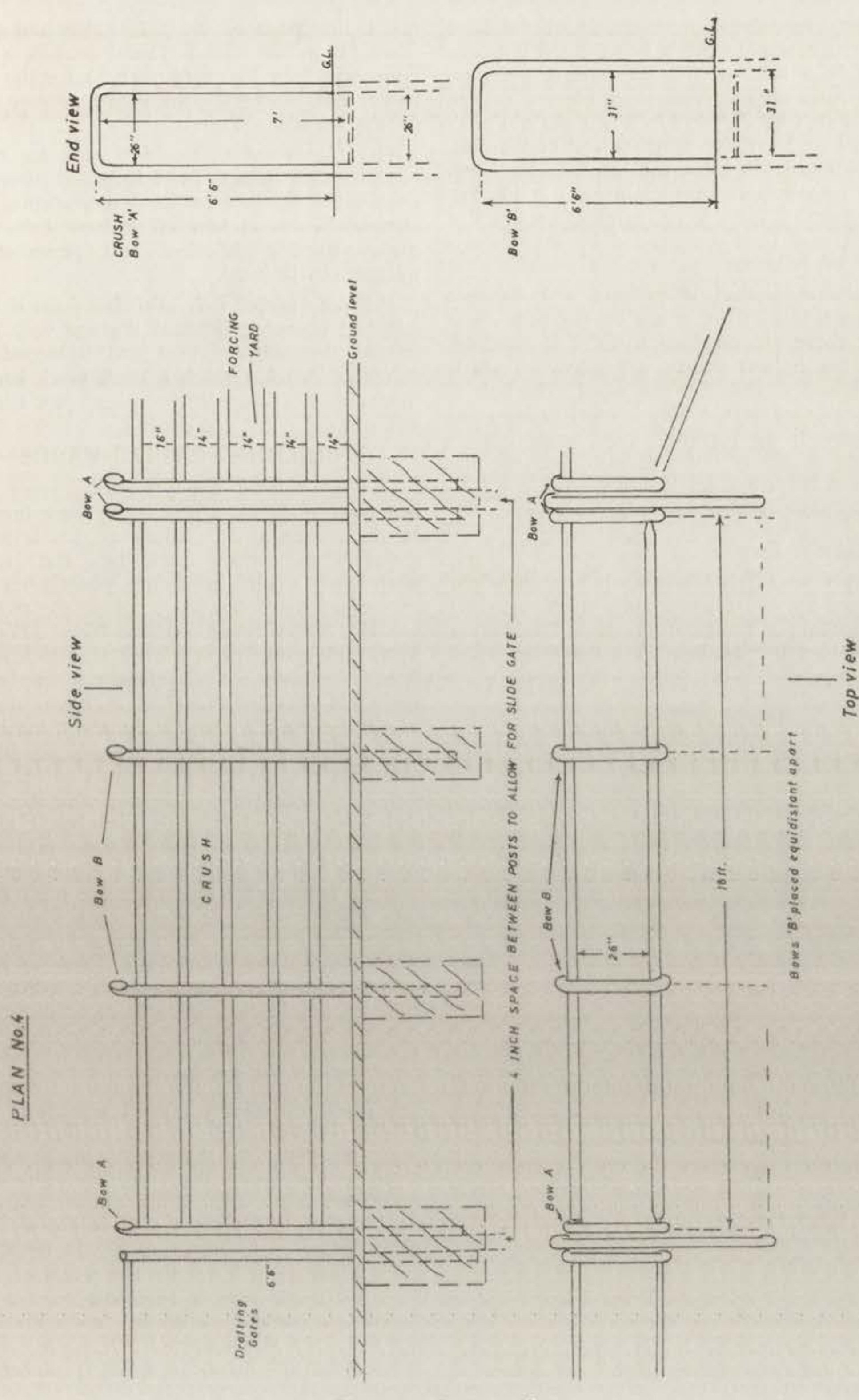

Figure 8.—Cattle crush

The measurements for the crush are the same as for the whole yard. When the rail positions have been marked, cut out enough wood on each mark on the posts to enable the rails to be let in (see *Figure* 3). When the rail positions have been cut, paint the rest of the post, including the cut areas, with preservative. Common preservatives are creosote or 50 : 50 creosote-sump oil mixture or any other preservative which may be recommended by the Department of Forests.

Another method is to bore a 1 in hole downwards into the centre of the post about 1 ft above ground level when it is standing. Into this hole is poured a preservative which is allowed to soak into the wood. The hole is then plugged with a bit of wood to keep out moisture. Every 3 months, more preservative is poured into this hole. Several cigarette tins full can be poured in, letting it soak in before adding more (*Figure* 3).

2. *Rails*

(a) *Pipe rails.*—Galvanized 2 in pipe can be used for the forcing yard, crush, vet. bail and loading and unloading ramps. These pipes are welded into position onto the 3 in galvanized pipe posts or the 2 in galvanized pipe bows (as in the crush). (See Plan No. 4 for crush and Plan No. 5 (*Figure* 9) for the vet. bail and drafting gates, and Plan 6 (*Figure* 10) for the unloading ramp.)

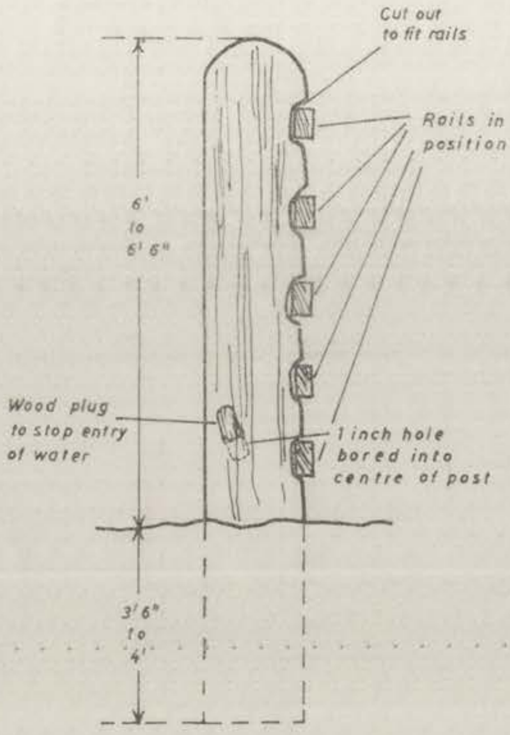

Figure 3.—Notches are cut out of posts to fit rails. A hole may be bored and preservative poured in

(b) *Hardwood rails.*—Ideal rails are 6 in by 2 in sawn timber, 18 ft long and preservative-treated. If sawn timber is unavailable, any straight hardwood logs of at least 4 in diameter, suitably debarked and preservative-treated, can be used.

Fastening timber rails to timber posts is best achieved by using doubled 8-gauge wire tied around the rail and post and tightened by means of twitching with a small pinch bar or the handles of large fencing pliers (see *Figure* 4).

C. BUILDING CATTLE YARDS

As was pointed out previously, yards are best built alongside a permanent fence line or on the corner of a paddock as this is most useful when driving cattle into the yards. Bearing in mind the future possibilities of expansion, the following 3 plans are recommended. You will see that Plan No. 1 (*Figure* 5) is quite sufficient as a basic plan to handle 5 to 15 beasts and additions can be fairly easily added as per Plan No. 2 (*Figure* 6) to enable the yards to handle up to 50 head of cattle. When further herd increases are planned, Plan No. 3 (*Figure* 7) shows an effective way of enlarging the yards to enable them to cope with up to 120 cattle. Plan No. 1 gives the basic plan for a crush, fencing yard and small yard to be built along a fence line. A point to remember is that the fence itself does not constitute one side of the yard. That part of the yard on the fence line must be built of timber or pipe posts and rails. Three or four strands of barbed wire would not withstand the inevitable hustle and bustle of cattle movement while in the yards.

PLAN No. 1

1. Mark out on the ground with pegs the position of the posts for the crush, forcing yards and small yard. Establish point Y which is on, or just inside, the fence line. The distance from Y to A is 54 ft. Other distances should be pegged out in a straight line as follows: A to D_1—18 ft; D_1 to X—18 ft; X to B—9 ft and B to Y—9 ft. The width of the crush is 26 in. This is to ensure that cattle cannot turn around inside the crush. Place a peg at C—24 in inside width if piping is to be used and 26 in inside width if timber is

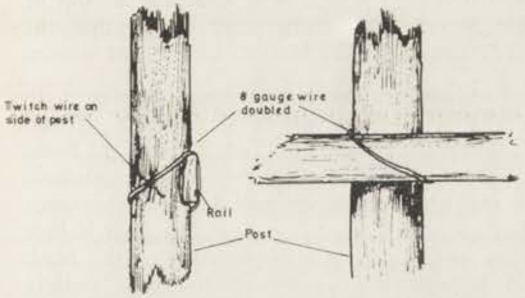

Figure 4.—Fastening of timber rails to posts

used. The distance C to D_2 is 18 ft. From point X measure 9 ft in a straight line to F; from F to E, 3 ft, and E to G a further 6 ft.

The distance from D_2 to E, if pegs have been placed properly, should be 20 ft 6 in. Place a peg half-way along between D_2 and E.

From peg Y measure 27 ft along the fence line, putting pegs at 9 ft intervals to point I, and put in a peg. From I to J—a distance of 27 ft—place pegs at 9 ft intervals.

2. Dig holes at all the peg marks. It is best to dig all the holes on one side first—say A to Y— to ensure they are in a straight line. Posts are 9 ft centre to centre except for the crush. With the crush the two end holes (i.e., A and D_1) are dug first and then 4 post holes in between A and D_1. That is, there are double posts at A and D_1 through which a gate slides and two more intermediate posts placed equi-

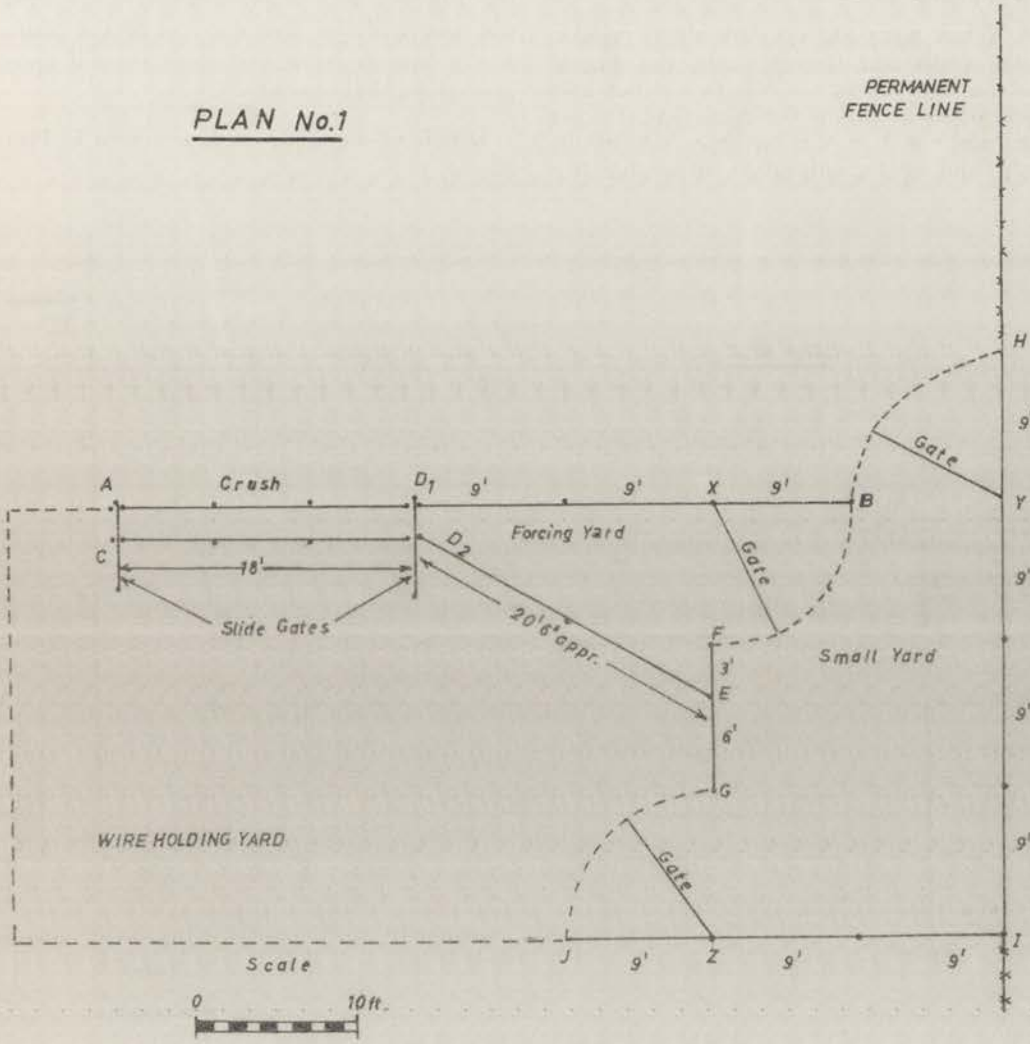

Figure 5.—Basic plan cattle yard (5 to 15 head) distant from A and D_1. Dig all the holes in this way one line at a time.

3. Stand up all the posts. It is best to do the end posts in each line first and line up the intermediate posts between them. Ram the posts in position, making sure that they are vertical.

4. Fix all rails to the inside of the posts—either with tie wire or welding (according to the materials used) where they are needed. When building yards, all rails should be on the inside for extra strength. When fixing rails inside the crush, remember to ensure that the inside width of the crush is never more than 26 in.

5. Brace the posts in the crush by joining the tops of the posts on each side with a length of 6 in hardwood.

6. When posts and rails are all in position in the crush and forcing yards, the ground must be dug out as follows. Dig it out to a depth of 6 in inside the crush and forcing yards and for 2 to 3 ft on either side of the crush—and replace with gravel. If possible, it is even better to put 2 in of concrete on top of this gravel. This work is to ensure that the yards remain workable even in the wet season.

7. Gates are hung on the straight fence. In Plan No. 1, these will be at points X, Y and Z. They are always hung on the straight fence to protect the gates against rushing animals. If the gates are open and lie along a fence they are less likely to be damaged than if they were lying open and in the path of the herd. To prevent the weight of the gate pulling down its support post, the posts must be braced in some way. You can nail a 6 in diameter piece of hardwood across the gateway. However, if you are driving cattle on horseback into the yards, it is better to brace the gatepost with stays. External gates need not necessarily be positioned as in the plans. Much depends on where fences are and upon general paddock layout.

Details of the cattle crush are given in Plan No. 4.

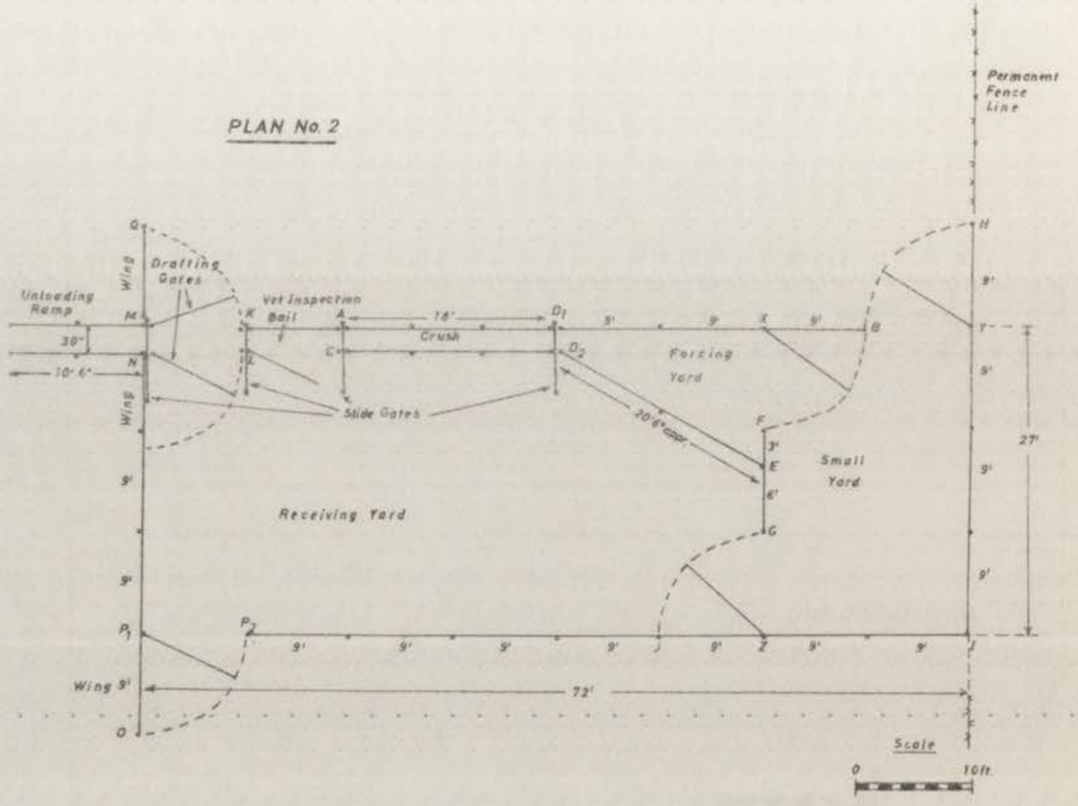

Figure 6.—Extension to basic yard (15 to 50 head)

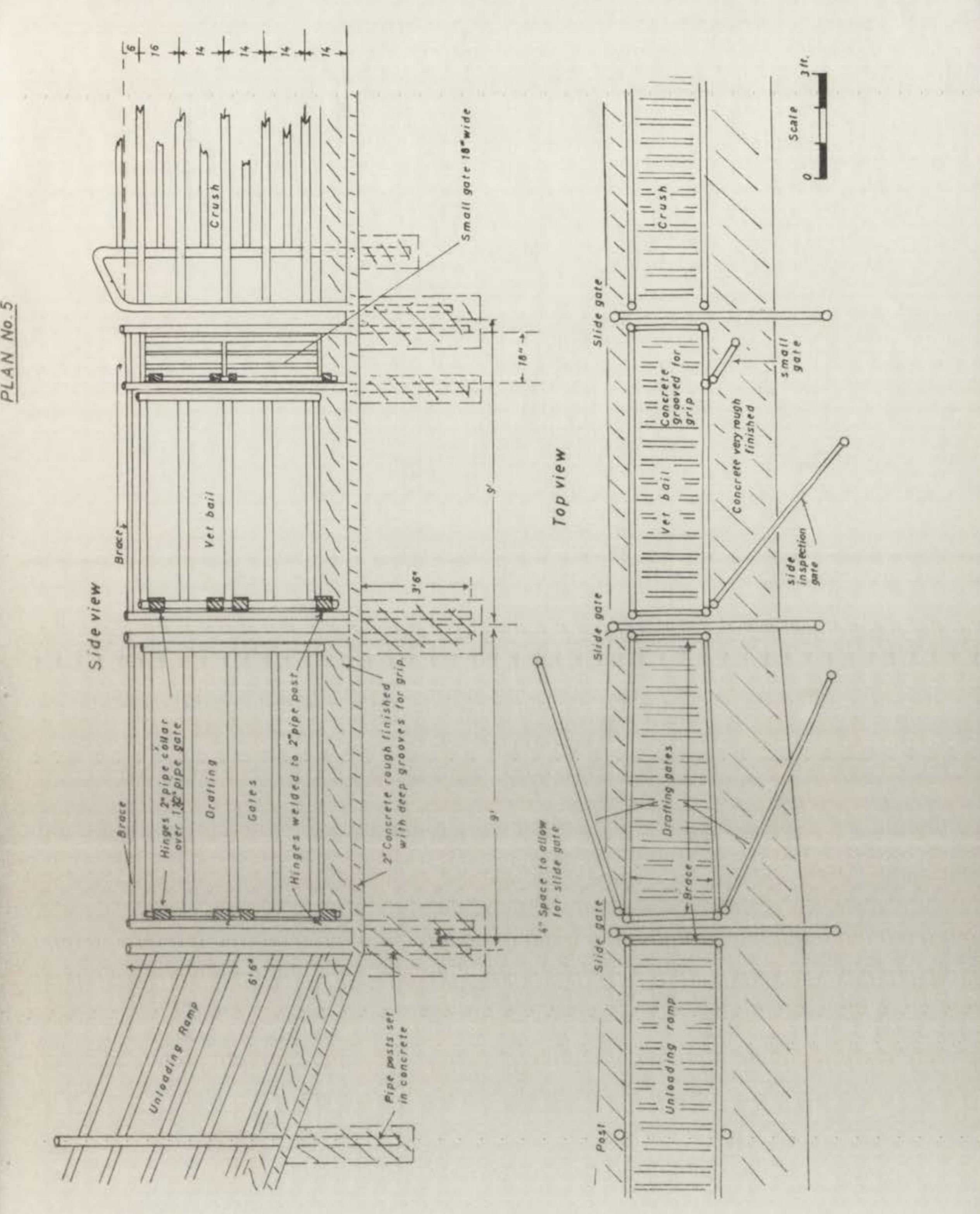

Figure 9.—Drafting gates and vet. bail

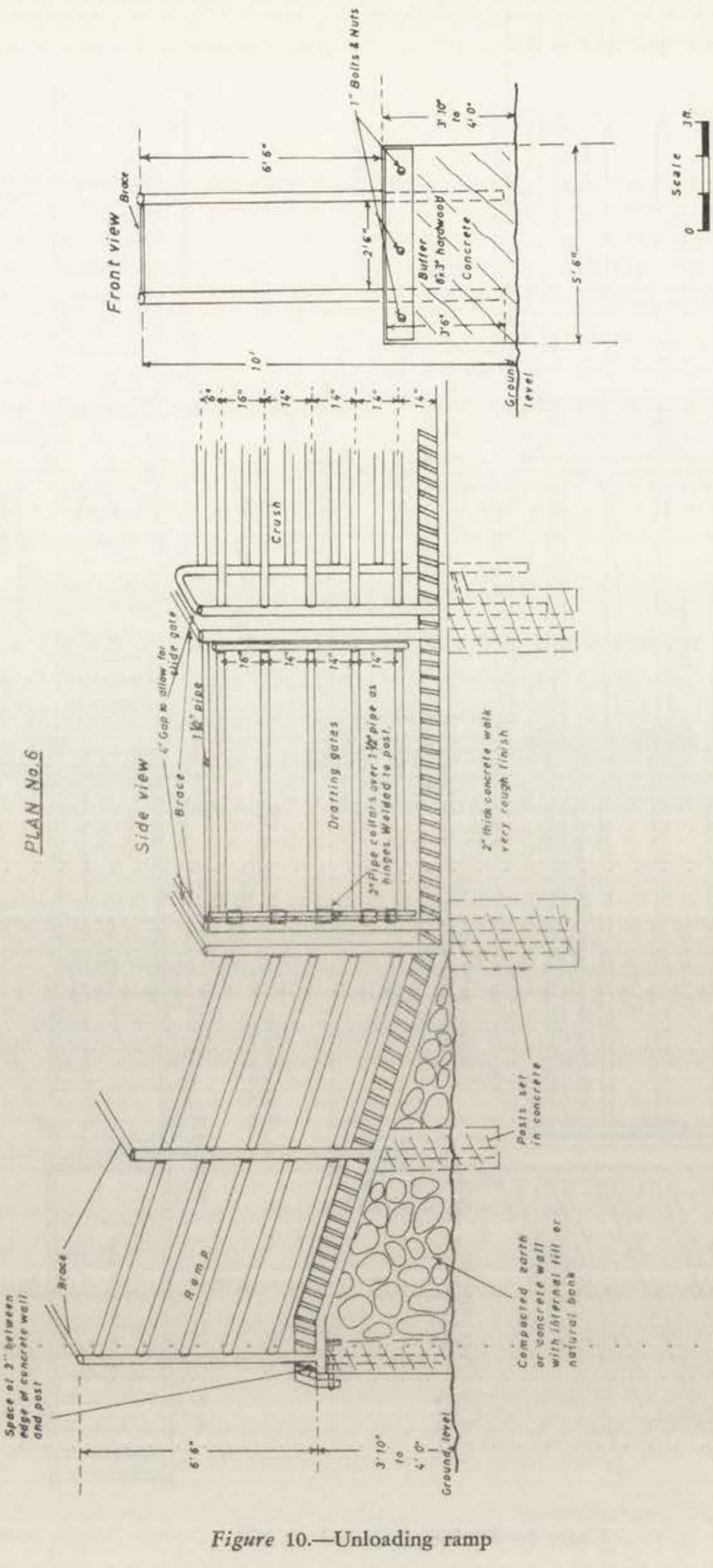

Figure 10.—Unloading ramp

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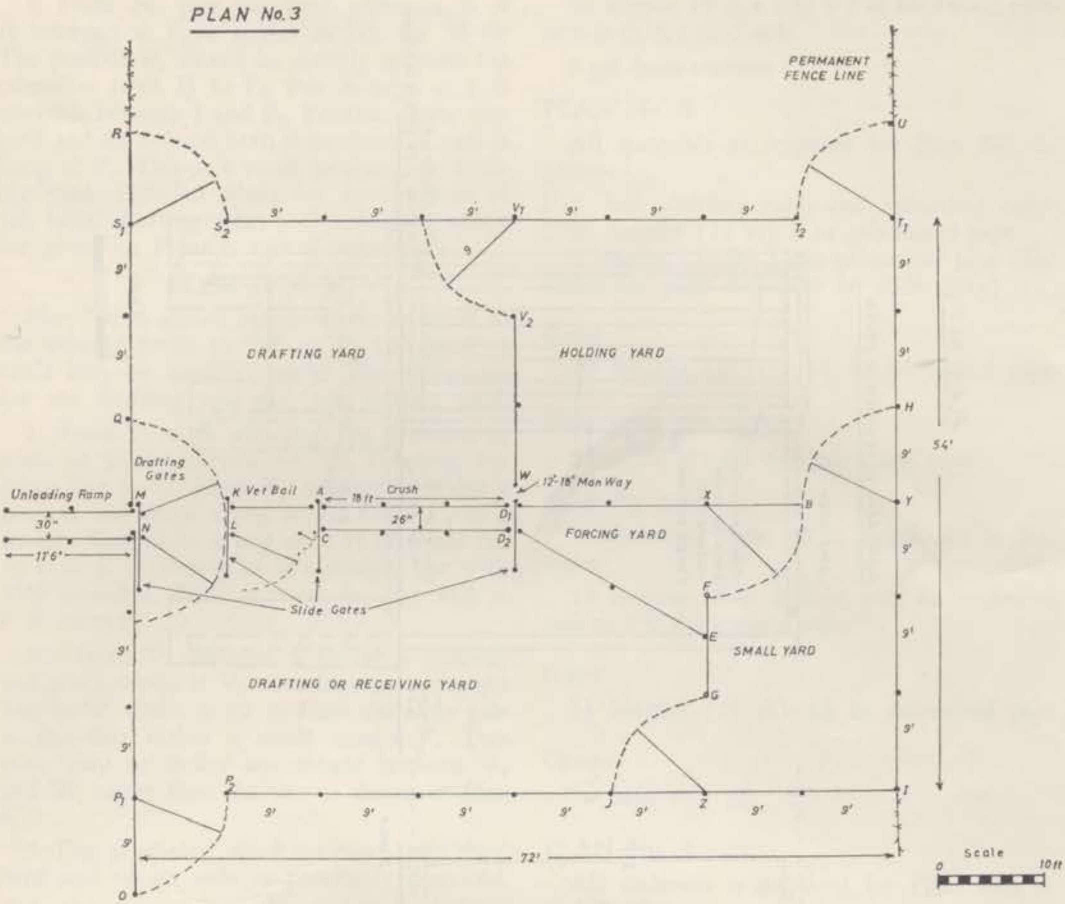

Figure 7.—Cattle yard extended to accommodate 50 to 120 head

Construct slide gates out of 2 in galvanized pipe (see Plan No. 7, *Figure* 11). The gate slide is made of 1½ in galvanized pipe. Plan No. 7 shows slide gates suitable for crushes and vet. bails. If making a slide gate for an unloading ramp, it should be 6 in wider. Old grease is used as a lubricant to allow the 2 in pipe to slide over the 1½ in pipe.

As cattle become very excitable if allowed to come straight out of a crush into a big paddock, a wire yard should be built off the end of the crush. Cattle can then be released from the crush and held in this yard until they settle down before moving them back to their paddock.

The approximate position of this yard is shown in Plan No. 1. The actual size of the yard will depend on the number of cattle held but should allow a minimum of 40 sq ft per beast.

PLAN No. 2

Plan No. 2 gives additions to the basic plan No. 1 to increase yard size to enable handling of up to 50 head of cattle. It adds a vet. inspection bail, drafting gates, loading ramp and a receiving yard.

1. Peg positions for double posts at K and L, 9 ft from A and C. Keep internal width of vet. bail the same as that of the crush. Dig holes, stand up posts, ram them and fix rails as described previously. A gate is hung at L. A small gate is also a good idea—hung from a post 18 in from C—to enable the inspector or vet. to enter the bail easily.

2. Peg the position of double posts at M and N, 9 ft from K and L. This time, however, the internal width of the loading ramp is wider—at least 30 in. Stand up posts and ram them hard. Gates (called drafting gates) are hung from both M and N.

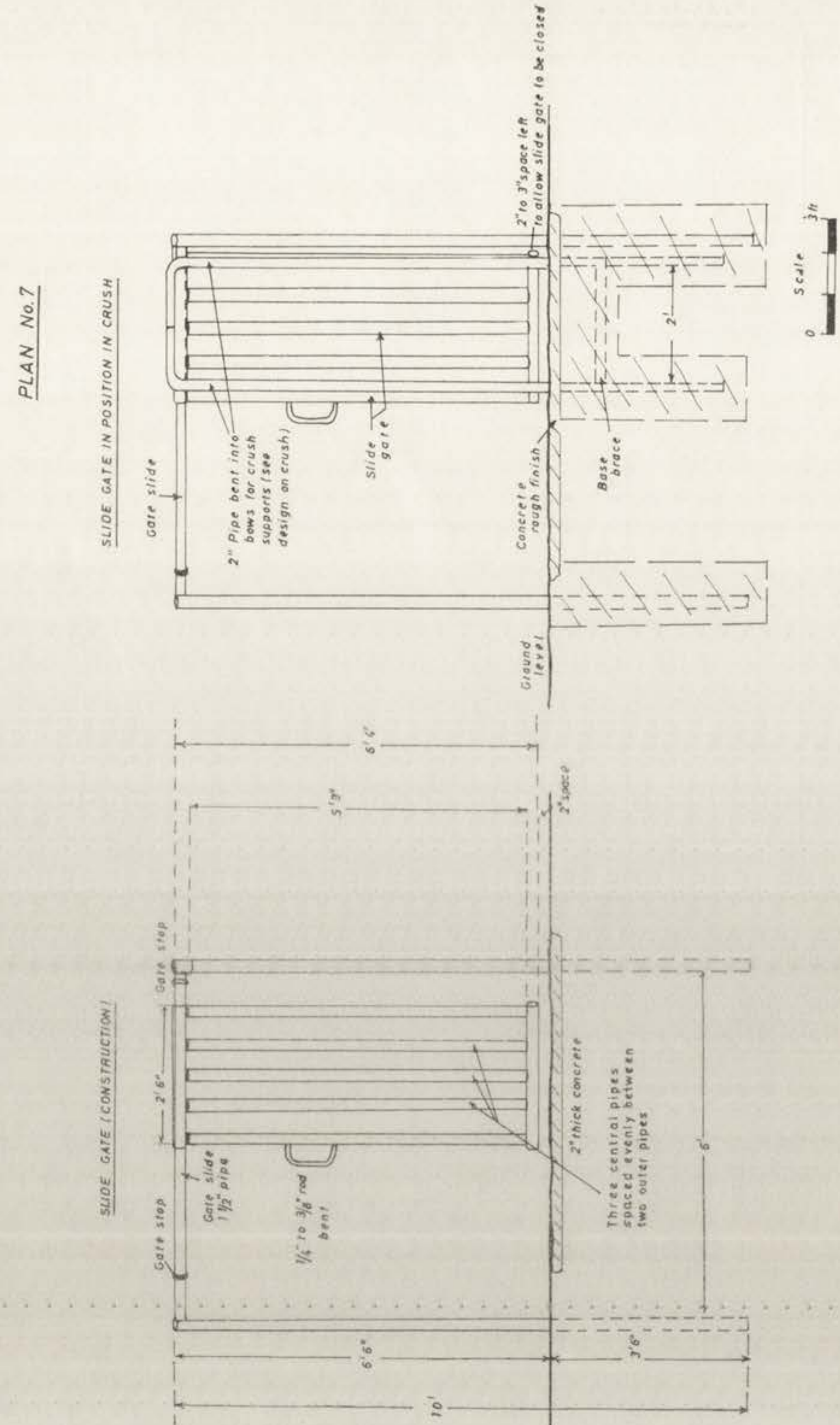

Figure 11.—Slidegate (for crush only). N.B.: Slidegate for unloading ramp should be 6 inches wider than this

3. From N, peg out post positions at 9 ft intervals at right angles to NL for 36 ft. The position P_1 should be directly opposite the extension from IJ to P_2. Put in pegs at 9 ft intervals between J and P_2. Position posts, ram hard and fix rails on both these lines. A gate is hung at P_1. This is a small receiving or drafting yard. Detailed plans for construction of vet. bails, drafting gates and unloading ramps are given on Plans 5 and 6 respectively.

PLAN No. 3

Plan No. 3 allows extensions to be made to the existing yards so that up to 120 head of cattle may be handled easily. The extensions are one drafting yard and one holding yard.

1. From Y, mark with pegs the positions of posts at 9 ft intervals for 36 ft along the fence line to U. From T_1 measure 9 ft for a gateway and place a peg at T_2. From T_2 in a straight line place a peg at 9 ft intervals for 63 ft to S_1. S_1 should be in a straight line with MN extended. Place pegs on the line MR at 9 ft intervals.

2. From V_1 measure 9 ft for a gateway and place a peg at V_2. Continue in a straight line to W which is 12 in from the slide gate at D_1—this makes a small 'man-way'. Two posts may be better equidistant between V_2 and W, rather than the one as shown in Plan 3.

3. Dig postholes, stand up posts, ram them hard and tie on rails as previously described.

4. Hang gates at S_1, V_1 and T_1 as before.

You now have a further drafting yard and a holding yard.

MATERIALS LIST

PLAN No. 1

Crush and forcing yard with wings

38 lengths (21 ft) 2 in galvanized pipe (includes bows as shown in Plan No. 4)

Gates

11 lengths (21 ft) 2 in galvanized pipe

Slide gates

8 lengths (21 ft) 2 in galvanized pipe
½ length (11 ft) 1½ in galvanized pipe

Cement

10 bags (1 in thick in crush plus posts cemented in holes)

Small yard

8 hardwood posts, 10 ft length, 12 in diameter

18 lengths 18 ft x 6 in x 2 in hardwood rails or 6 in thick round rails

5 gal drum creosote

PLAN No. 2

All materials as required for Plan No. 1, plus—

Vet. bail, drafting gates and unloading ramp
21 lengths (21 ft) 2 in galvanized pipe
2 lengths (21 ft) 1½ in galvanized pipe (for braces for gates and slide for slide gates)

Gates

14 lengths (21 ft) 1½ in galvanized pipe

Slide gates

8 lengths (21 ft) 2 in galvanized pipe

Receiving yard

7 hardwood posts, 10 ft length, 12 in diameter

18 lengths 18 ft x 6 in x 2 in hardwood rails or 6 in thick round rails

Gates

3½ lengths (21 ft) 1½ in galvanized pipe

Cement

10 bags

PLAN No. 3

All materials as required for Plans Nos. 1 and 2, plus—

Drafting and holding yard

16 hardwood posts, 10 ft length, 12 in diameter

35 lengths 18 ft x 6 in x 2 in hardwood rails or 6 in thick round rails

Gates

10½ lengths (21 ft) 1½ in galvanized pipe
3 lengths (10 ft) 6 in x 2 in hardwood rails for gate brace

Complete materials list for Plan No. 3

74½ lengths (21 ft) 2 in galvanized pipe

41½ lengths (21 ft) 1½ in galvanized pipe

20 bags cement

31 hardwood posts, 10 ft long, 12 in diameter

72 lengths 18 ft x 6 in x 2 in hardwood rails or 6 in thick round rails

5 drums (5 gal) creosote

A Comparison of Weed Control Programmes in Coffee

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A previous article in Harvest (*Vol.* 1, *No.* 3) *described two weed control trials in coffee at Aiyura. They were in coffee which was heavily infested initially with perennial grasses and this resulted in all treatments being relatively expensive. The trial described here was on a plantation with a more normal weed population, and the costs quoted are more directly comparable with most other highlands coffee areas.*

One of the treatments compared in this trial is based on the soil-applied herbicide simazine. A recent large price drop has brought this herbicide into consideration for use in coffee so its performance in this trial is of interest.

As in the previous article, herbicides are generally referred to by the common name of their active ingredient. Where details of trial treatments are given, however, it is usually more convenient to refer to the commercial product used in the trial and the quantity quoted is then the quantity of that product (not of the active ingredient). The naming of a commercial product does not imply any preference over another product containing the same active ingredient. *Table* 1 gives the trade names of formulations of the herbicide chemicals referred to in this article.

Table 1.—Glossary of trade names and common names

Common Name	Trade Names*
Paraquat	Gramoxone
Diuron	Diurex, Karmex
Amitrole	Weedazol TL Plus
Dalapon	Basfapon, Dowpon, Gramevin
2,4-D	Amoxone-50, Weedkiller D
MSMA	Ansar 529, Daconate
MCPA	Methoxone-30
Simazine	Gesatop-80

*This list is not exhaustive, but includes products most readily available in Papua New Guinea.

The trial which commenced in January, 1970 was on Aionora Plantation near Kainantu, in mature multiple stem coffee spaced at 9 by 9 ft. Initially the coffee was under light Albizia shade but this was removed after the trial had been running for a few months. The area used had not previously been treated with herbicides.

The trial compared four weed control treatments, each on an area of 1 acre. The trial area was heavily infested with weeds, but they were almost entirely annual species. The main species present at the beginning were *Galinsoga parviflora*, *Bidens pilosa* (cobbler's peg), *Eleusine indica* (crowsfoot grass), *Amaranthus lividus* and *Crassocephalum crepidioides* (thickhead). There were also about 15 other species present in lesser amounts, including the perennials *Commelina diffusa* (wandering jew), *Cynodon dactylon* (couch grass) and *Paspalum conjugatum* (thurston grass). All these weeds are illustrated in the booklet *Weeds of Coffee in the Central Highlands, Botany Bulletin No.* 4, by E. E. Henty, published by the Division of Botany, Department of Forests.

The four treatments were—

(1) *Based on paraquat.* Paraquat was applied to emerged weeds as required. Initially this was as a blanket spray but as the weed cover decreased it became a spot-spray. Other herbicides were to be used as necessary to control weeds not adequately controlled by paraquat. The only additional herbicide used was amitrole.

(2) *Based on diuron.* The diuron was applied as blanket sprays to predominantly bare ground at intervals of from 4 to 8 months. In between these applications, spot-sprayings of species which were not being controlled were made with the most appropriate foliar-acting herbicide. The additional herbicides used in this way were dalapon, amitrole, paraquat and 2,4-D.

(3) *Based on simazine*. The simazine was applied as blanket sprays to predominantly bare ground at intervals which ranged from 4 to 8 months. Weed species not being adequately controlled by these applications were spot-sprayed with the most appropriate foliar-acting herbicide. The additional herbicides used were dalapon, amitrole, paraquat, 2,4-D and MCPA.

(4) *Hand-weeded*. This was done using spades, at intervals comparable with normal plantation practice. Whenever possible weeding was done during periods of dry weather, so that a good kill of weeds would be obtained.

At the beginning of the trial, the herbicide plots were hand-weeded. This was necessary in the case of the diuron and simazine plots to allow the first application of these herbicides to be made to predominantly weed-free ground. For uniformity, and because the weed growth was too high to permit easy and safe spraying, the paraquat plot was also weeded. In each case the cost of the weeding was included in the costs of the control programme. The hand-weeding cost was a necessary part of the soil-applied treatments, but could have been avoided in the paraquat treatment. The replacement of a paraquat application by a hand-weeding probably added about one dollar to the cost of the paraquat-based treatment.

RESULTS

The costs of the four treatments over the 2-year period are given in *Table* 2. The following is a summary of the applications made in each treatment during the trial, and the results obtained:—

(1) *Based on paraquat*. In the first year there were 7 applications of paraquat, made at intervals of 6 to 8 weeks. The first two were with a spray concentration of 1 pint of Gramoxone per 45 gal, the next two with 2/3 pint and the remaining 4 applications were with a concentration of ½ pint per 45 gal of spray. In each case a surfactant was included at a concentration of ½ pint per 45 gal of spray. For the first application, 38 gal of spray were required to cover the 1 acre area, but by the end of the year this had dropped to 25½ gal due to the decreased weed cover. In addition to the paraquat sprays, amitrole at a concentration of 4 pints of Weedazol TL Plus was applied on one occasion to small patches of thurston grass.

In the second year, there were 7 applications of paraquat, all at a concentration of ½ pint of Gramoxone per 45 gal, and one application of amitrole to small amounts of thurston grass. By the end of the second year the volume of spray per application was down to 17 gal per acre.

The treatment maintained effective weed control throughout the 2 years. Five weeks after the final application the percentage of the plot covered by weeds was only about 3 per cent. During the trial there had been some change in the relative proportions of the weed species present. In particular, there was a relative increase in *Polygonum nepalense*, crowsfoot grass and *Cyperus brevifolius*. These species are only just controlled by the spray concentration of ½ pint per 45 gal and need to be sprayed before they reach the flowering stage. There was a relative decrease in *Drymaria cordata* while *Galinsoga parviflora* had disappeared by the end of the second year. However, the disappearance of this weed may have been due to some seasonal effect rather than to the treatment, because it was also absent from the hand-weeded treatment at the end of the second year.

The particularly low cost of the paraquat-based treatment in the second year was due partly to a prolonged dry spell during the latter part of the year. At this time there was a 9-week interval between sprays. Whilst the costs obtained for this period can be considered abnormally low, it can be seen from the costs incurred during the first half of the second year when weather conditions were normal, that the treatment was still relatively inexpensive.

(2) *Based on diuron*. In the first year there were three blanket applications of diuron. The first application at week 1 was at the rate of 4 lb Karmex or Diurex per acre, and the next two, at weeks 16 and 38, were at 2 lb per acre. The spray volume used varied from 36 to 45 gal per acre. In addition there was one spot-spraying with 2,4-D (at 3 pint Weedkiller D per 45 gal) and five spot-sprayings with paraqat (at 2/3 to 1 pint Gramoxone per 45 gal) for weeds which were not adequately controlled by the diuron applications. By far the most plentiful of the species treated in this way was thickhead, but also present were cobbler's peg, crowsfoot grass and minor amounts of other species.

In the second year there were blanket applications of diuron at weeks 61 and 97. Both were at the rate of 2 lb Karmex or Diurex per acre. The second application was postponed for some weeks because of abnormally dry weather. Without rainfall the diuron is not washed into the soil, and so cannot kill the germinating weeds. In addition there will be some decomposition of the herbicide if it remains exposed on the soil surface for an extended period. Instead of applying the diuron at the correct time, that is when a significant number of weed seedlings were starting to appear about 6 months after the previous diuron application, these seedlings were allowed to grow and were spot-sprayed with paraquat when they were about 8 in high.

During the second year there were five spot-sprayings with paraquat, at concentrations of ½ to 1 pint of Gramoxone per 45 gal. The main weed sprayed each time was thickhead. In this period these sprayings required only low volumes of spray per acre—6½ gal in the case of the final spot-spraying.

The treatment kept the area very clean throughout the 2 years, although a considerable number of spot-sprayings were required to achieve this. If the species which are resistant or less susceptible to the diuron treatment had been allowed to seed and spread, then the control of the area would soon have become inadequate. The ground covered by weeds was never above 10 per cent of the total area, and mostly was not above 2 per cent. Usually it was cleaner than the paraquat plot.

The treatment resulted in changes in the relative quantities of the different weed species. In particular, thickhead greatly increased, while there was also some increase in crowsfoot grass, cobbler's peg and *Polygonum nepalense*. *Galinsoga parviflora*, *Ageratum conyzoides* (goatweed), *Youngia japonica* and wandering jew have either disappeared or have been reduced relative to the other species.

(3) *Based on simazine*. In the first year there were three blanket applications of simazine. These applications were made at weeks 1, 15 and 33 at the rate of 4, 2 and 2 lb Gesatop-80 per acre respectively in a spray volume of 36 to 41 gal per acre. Spot-sprayings were applied as required with 2,4-D (once), MCPA (once) and paraquat (four times), all mainly for *Amaranthus lividus*, although lesser amounts of cobbler's peg, crowsfoot grass, *Galinsoga parviflora* and other species were also treated. In addition small patches of couch grass were treated with 2 applications of dalapon (at 5 lb Gramevin per 45 gal) and small patches of thurston grass and *Cyperus brevifolius* were treated with 2 applications of amitrole (at 4 pints Weedazol TL Plus per 45 gal).

In the second year blanket applications of simazine at 2 lb Gesatop-80 per acre were sprayed at weeks 61 and 97. As in the diuron treatment, this last application was postponed until a break occurred in a prolonged spell of dry weather. Spot-sprayings were made with paraquat on seven occasions.

The treatment maintained good weed control although the area was at all times somewhat weedier than the diuron-treated plot, with weeds often covering up to 15 per cent of the area. It also required more frequent spot-spraying than the diuron plot. Against this however, the lower cost of the simazine compared with diuron has resulted in cheaper control.

As with the other treatments, there was a change in the relative proportions of the weed species over the trial period. The most noticeable change was the increase in *Amaranthus lividus* but there was some relative increase in crowsfoot grass and *Cyperus brevifolius*. Cobbler's peg, thickhead, goatweed, wandering jew and *Polygonum nepalense* have decreased while *Galinsoga parviflora* and *Drymaria cordata* were not present at the end of the second year.

(4) *Hand-weeded*. There were six weedings in the first year, at intervals of 9 to 12 weeks. In the second year there were four weedings, at intervals varying from 9 to 18 weeks. The long interval occurred during the dry period referred to previously. During the trial, the main change in the weed population was an increase in the proportion of wandering jew and the disappearance of *Galinsoga parviflora*. An increase in a species such as wandering jew which can spread from cut portions of stem is to be expected under hand-weeding, but the reason for the disappearance of *Galinsoga parviflora* is unknown.

In the situation which existed in this trial, where the weed species were predominantly annuals and the area was well drained, manual weeding can be relatively inexpensive. However, the costs given should be regarded as optimal because the labour was working under close supervision and for only short periods at each weeding. On a plantation scale, under less supervision, the weeding costs could be expected to be higher.

There was a considerable drop in the cost of hand-weeding in the second year. In part this was due to a period of dry weather, but this doesn't account for most of the decrease. It may have been a consequence of the relative smallness of the treatment area. It is possible that as the labour became familiar with the task involved their work output increased in order to finish the task more quickly and return to less arduous work.

DISCUSSION

The costs of all treatments dropped markedly in the second year. With the herbicide treatments this is the expected pattern, although in this trial the decrease was somewhat larger than normal because of a long period of dry weather in the second year and the virtual absence of perennial species capable of taking advantage of the bare ground.

As has usually been the case in other trials, the treatment based on paraquat was the least costly, even though the hand-weeding costs obtained were probably lower than could be expected on plantations. The paraquat-based treatment has been much cheaper over the trial period than the two treatments based on soil-applied herbicides and it seems unlikely that this position would change in future years.

As already indicated, the simazine-based treatment gave somewhat inferior weed control to the diuron-based treatment. It is possible that better results could have been obtained if higher rates of simazine were used, although this may have brought the control costs closer to those obtained with the more expensive diuron-based treatment.

Neither diuron nor simazine control the full range of species present in coffee. Among annual species, diuron's most obvious weakness is thickhead, while simazine gives no control of *Amaranthus lividus*. Diuron is able to kill larger seedlings than simazine and is somewhat better on perennial weeds, particularly thurston grass. At equivalent rates, it therefore generally gives slightly superior results to simazine.

A possible way of reducing the cost of treatments based on soil-applied herbicides would be to use both diuron and simazine in the spray programme so that the number of species controlled is increased. This could be done by applying diuron and simazine either in alternate applications, or in alternate years, or by applying them mixed together at each application. In a trial where they were applied together at 2 lb plus 2 lb (of commercial product) per acre, the length of control obtained was comparable to that obtained with either herbicide applied alone at 4 lb per acre.

However, under conditions comparable to that existing in the trial described here, it would not be expected that any combination of soil-applied herbicides would, at present prices, give cheaper control than a treatment based on paraquat.

ACKNOWLEDGEMENT

The co-operation and assistance of the owners and manager of Aionora Plantation during the running of the trial are gratefully acknowledged.

Table 2.—Costs per acre of weed control treatments

Treatment	COSTS 1st 6 months	2nd 6 months	Total 1st year	3rd 6 months	4th 6 months	Total 2nd year	2 year total
	$	$	$	$	$	$	$
Based on paraquat	11.93	6.32	18.25	4.30	2.30	6.60	24.85
Based on diuron	26.00	11.56	37.56	9.62	7.35	16.97	54.53
Based on simazine	21.65	8.33	29.98	9.02	6.80	15.82	45.80
Hand-weeded	10.17	7.87	18.04	4.81	3.03	7.84	25.88

Prices used in compiling costs:—

Agral 60 (surfactant)—$6.20 per gal.
Gesatop-80—$1.75 per lb
Gramevin—$0.55 per lb
Gramoxone—$21.50 per gal
Karmex—$3.10 per lb
Methoxone—$3.40 per gal
Teepol—$1.18 per gal
Weedazol TL Plus—$7.50 per gal
Weedkiller D—$5.19 per gal
Labour—10.1c per man hour

Cattle Breeding at P.A.T.I.

An Exercise in Up-grading

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Popondetta Agricultural Training Institute

The cattle now held at the Popondetta Agricultural Training Institute provide a good example of up-grading a herd of cattle through the use of high-grade bulls and careful selection techniques.

The first cattle received at P.A.T.I. were very poor quality. The original bull was one of a group of domesticated cattle which had gone wild. It was rounded up with others on Normanby Island and brought across to Popondetta. Other early additions to the herd came from a number of different D.A.S.F. herds, and were also of poor quality with little or no Zebu blood. With the arrival of a ¼ Africander/Shorthorn bull from Erap, a start was made to up-grade these original cattle. This was continued with the use of Brahman-cross bulls from Moitaka. At all times careful selection of the progeny of these bulls was carried out to ensure that the right animals were used in the up-grading programme.

The up-grading is illustrated in the following photographs. These photographs show the important characteristics which were selected for during the up-grading programme and the way in which the type of cattle at P.A.T.I. have improved through the use of these techniques.

Plates I and II show typical examples of the original cattle at P.A.T.I. *Plate* I is a photograph of the ¼ Africander bull brought from Erap. His coat is fairly short and fine, but not fine enough and the conformation of his hind quarters is not particularly good. He did, however, have ¼ Zebu blood (in this case Africander) and it seemed likely that some of his progeny would show some of the bull's better qualities. The cow shown in *Plate* II is a pure British breed (in this case an A.I.S.). She has the coarse, fairly long hair which indicates poor sweat gland development and hence inability to put up with high temperatures and humidity. Although she, as a dairy type, was not suited ideally to the breeding of beef cattle, she was likely to be a good mother because of her good milk supply. She would therefore serve as a useful start for the up-grading programme.

When these two cattle were mated, the progeny (shown in *Plate* III) showed some better qualities than the dam, for example a finer coat and thus a few more sweat glands, but her low growth rate indicated that she was not completely suited to the environment and that further up-grading was necessary.

She was therefore mated to the ¾ Brahman bull shown in *Plate* IV. This bull has a lot more Zebu blood, has a fine coat (more sweat glands) and is able to graze out during the day and grow well under hot conditions. The progeny from this mating is the heifer shown in *Plate* V and it is clear from this photograph how the quality has improved from the original cow seen in *Plate* II. She has better conformation, fine, short hair, loose skin folds and, most important, her high growth rate showed that she was performing well in the P.A.T.I. environment.

This heifer was therefore selected to be mated to a different ¾ Brahman bull (*Plate* VI). At *Plate* VII is a photograph of the progeny from this mating. From the photograph it is possible to see the very fine, short coat and the excellent hind quarter development—compare this with the poor hind quarter conformation of the original bull in *Plate* I. What the photograph does not show, however, is that this calf weighed over 400 lb at 7 months of age—almost 50 per cent better than the growth of the original cow we saw in *Plate* II.

The improvement in both weaning weight and the age of maturity are in fact the two outstanding factors which can be seen over the whole herd as a result of this up-grading programme. In 1967 calves were weaned at 7 months of age, with weaning weights ranging from 270 lb to 350 lb liveweight. In 1970 calves weaned at 7 months had liveweights of 400 lb to 450 lb. Similarly, 1968 calves had to

Plate I.—$\frac{1}{4}$ Africander bull

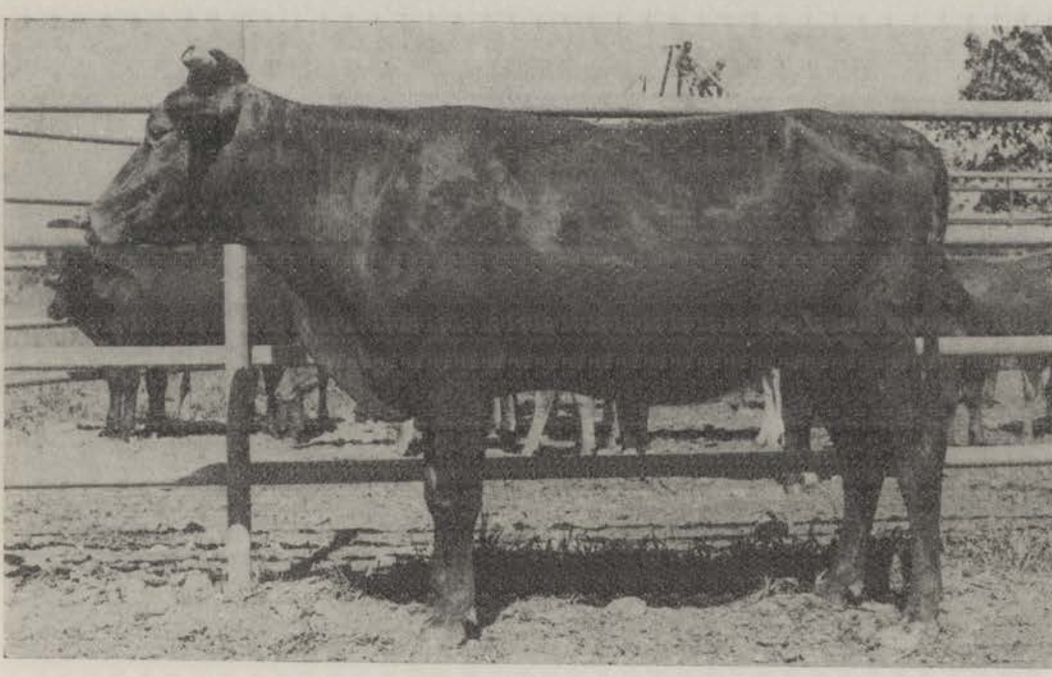

Plate II.—A.I.S. cow

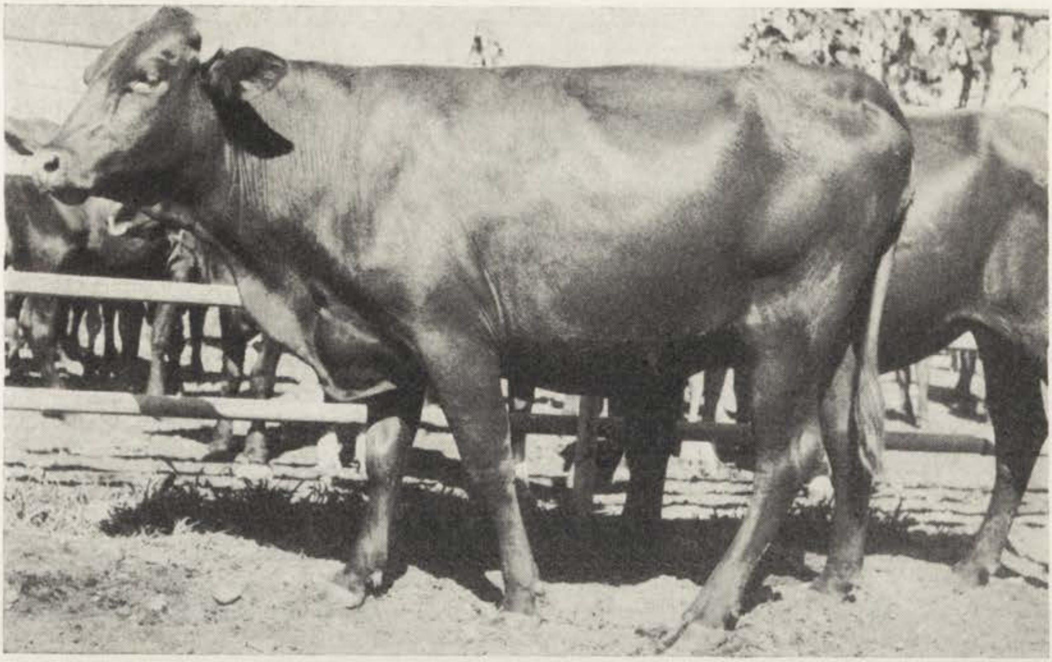

Plate III.—Progeny of the first mating

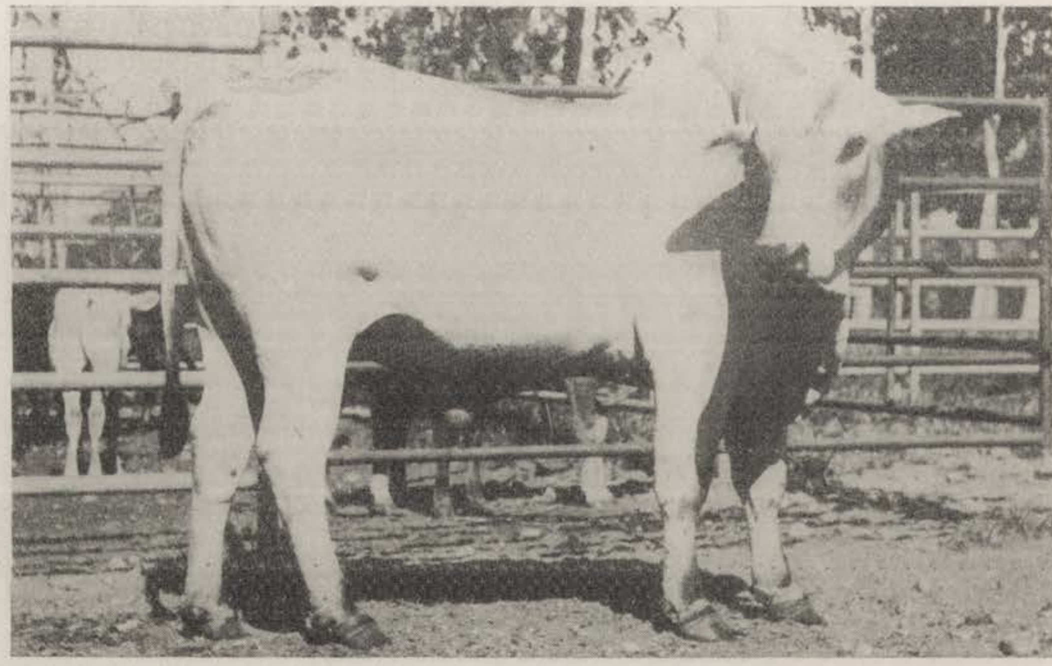

Plate IV.—First ¾ Brahman bull

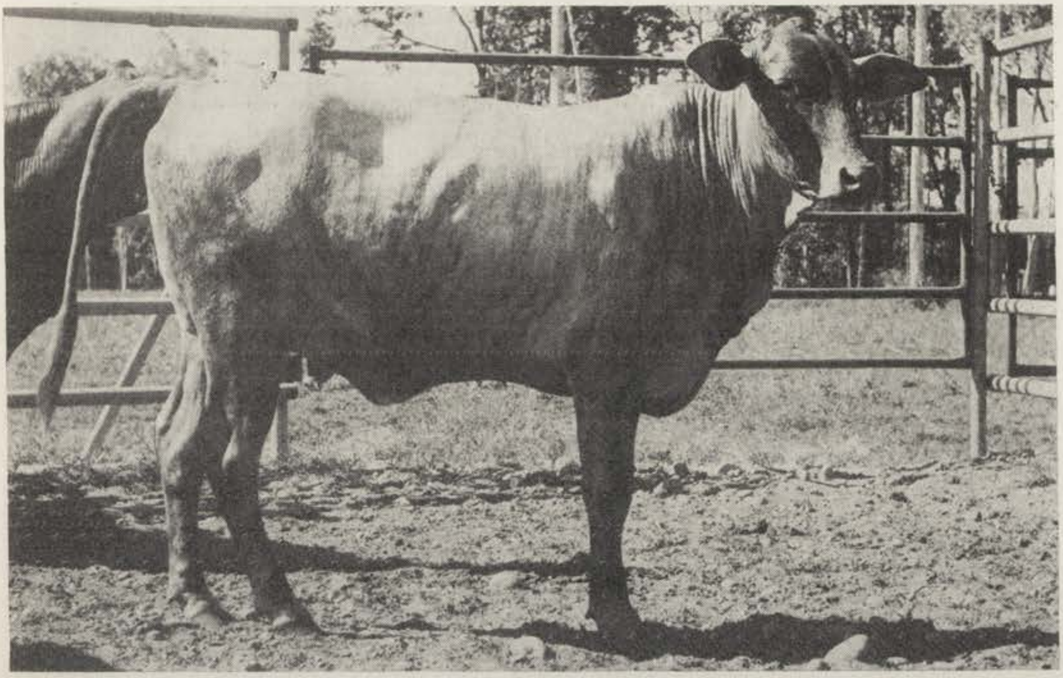

Plate V.—Progeny of the second mating, showing better conformation, fine short hair and loose skin folds

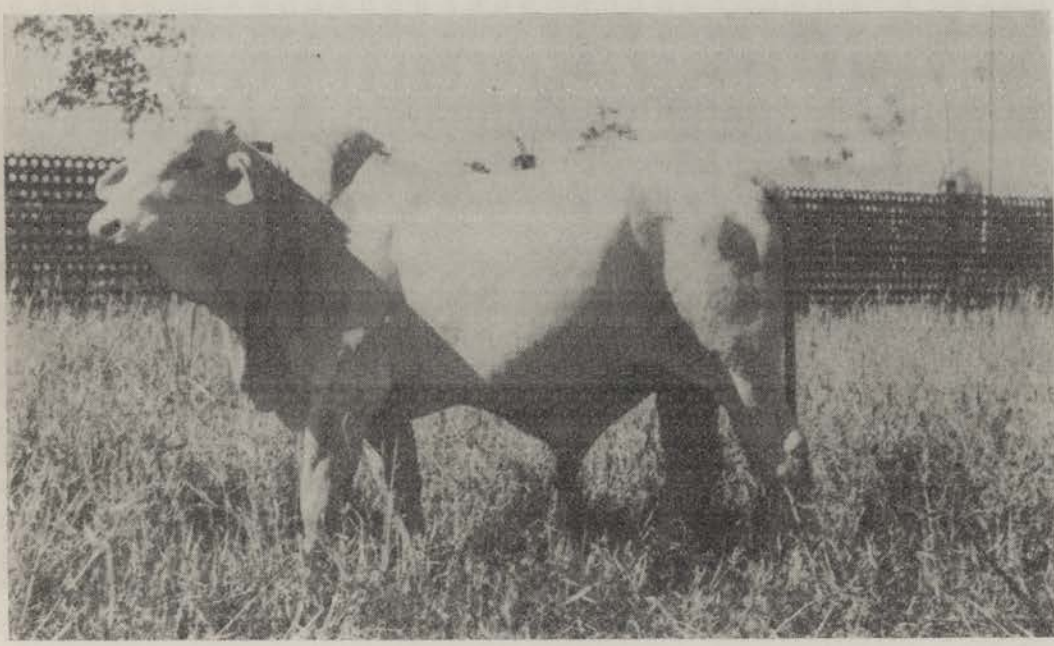

Plate VI.—Second ¾ Braham bull

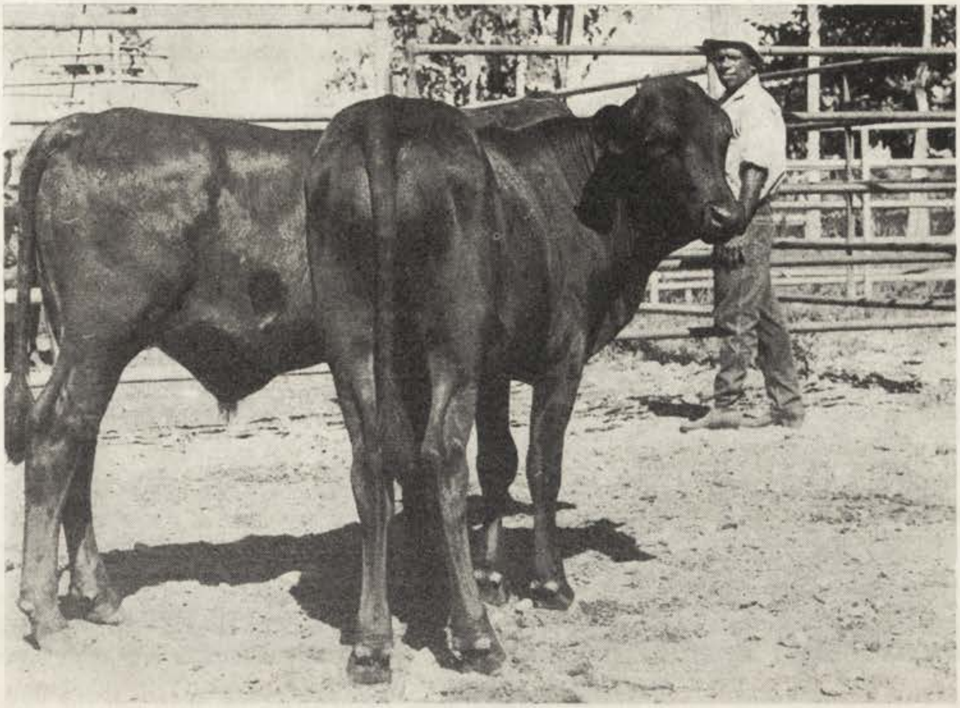

Plate VII.—Progeny of the third mating. These 7-month old calves show excellent hind quarter development and are already over 400 lb liveweight

be kept to an age of 2 years to reach 600 lb liveweight for mating. Most of the 1969 calves, however, exceeded 600 lb at 16 months of age. Thus the benefits of the up-grading programme can be seen not only in the photographs shown here, but also in the growth and reproductive performance of the cattle. On a commercial farm this would be more evident as increased profit.

The work being done at the New Guinea Lowlands Livestock Station, Erap, on the evaluation of different levels of Zebu blood, together with the results of further up-grading programmes on herds such as the P.A.T.I. herd, will help to show just how far these programmes can be taken. For example, it may be that too much Zebu blood will result in poor reproductive performance. The results shown by the P.A.T.I. programme, however, indicate that a considerable improvement can be gained by up-grading at least to the level of $\frac{1}{2}$ Brahman.

Tomato Growing in the Wapenamanda Subdistrict

MIKE HERMAN, Staff Agriculturalist,
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Growing good tomatoes consistently is possible if the grower is willing and able to maintain a high level of management. More so than any other crop in the experience of the author, tomatoes will respond to good management, but results will be poor without it. The author has grown tomatoes in four different areas in the Wapenamanda Subdistrict. All areas were near 5600 *ft above sea level.*

Climatic Conditions

Trials now in progress are expected to show advantages for certain varieties at different times of the year. The main factor is the amount and timing of water available. A 4-year average rainfall at Wapenamanda showed 100.72 in annual rainfall with a high month of February (13.65 in) and a low month of July (3.36 in). The averages are deceiving in that we often get long periods without any rain. During July and August, 1971, we experienced a 4-week period without rain, and irrigation was necessary at that time for plants less than 6 weeks old.

Ground Preparation

Soil broken from pasture or bush will rarely produce a good tomato crop in the first year. I suggest planting a crop of sweet potato initially and at the same time incorporating 1 ton per acre of limestone ($CaCO_3$). After removal of the sweet potato, the ground should be ready to plant tomatoes. Tomatoes do not like wet feet, so careful attention should be given to drainage.

PLANTING PROCEDURES

All tomatoes are started in the greenhouse in a medium of ½ coffee hulls and ½ black soil (by volume). Pre-planting fertilizer per box is—

- 1 tablespoon limestone
- 1 tablespoon triple superphosphate
- 2 tablespoon ammonium nitrate

One tablespoon of seed is scatter-planted in one box and transplanted when 1 to 1½ in tall to other prepared boxes at a 2 in by 2 in spacing (64 plants in a box 18 in by 18 in by 3 in). Only water is given during the sprouting period. After sprouting and until transplanting outside, 1 quart per box per day of the following mix is given:—

- 44 gal water
- 1/3 cup muriate of potash
- 1/3 cup magnesium sulphate
- 1/3 cup di-ammonium phosphate (20 per cent N, 21.8 per cent P)
- 2/3 cup ammonium nitrate

If damping off becomes a problem, use a seed sterilant, e.g. Panogen.

Transplanting (Greenhouse to Garden)

The optimum time to plant outside is when the seedlings are 8 to 10 in tall. Harden the plants by putting the box outside for 3 days before transplanting. Plant in the horizontal-vertical position as follows—strip all the leaves off except the top three, and lay in a trench. Gently bend the head of the plant to a vertical position and cover the horizontal part of the seedling with 1 to 2 in of soil. Leave only 3 to 4 in of the original plant exposed. We use a 30 in by 30 in spacing.

Transplant Mix

Several experiments have proved the value of a transplant mix (starter solution) both in early growth and later production. It includes water plus quickly available plant nutrients plus a fungicide. One mix that has proved successful is as follows:—

- 5 lb ammonium nitrate
- 5 lb magnesium sulphate
- 2½ lb muriate of potash
- 15 lb di-ammonium phosphate
- 2½ lb Zineb 65
- 2½ lb copper oxychloride
- 10 oz sodium molybdate (39 per cent Mo)

Plate I.—The wife of the author assists in the supervision of the work at Mukulamanda Agricultural Centre. Mrs Herman is seen here with Mark Angala, the Chief Garden Supervisor

Of the above dry mixture, 6 oz are mixed with 4 gal of water. Apply 1 pint of this mix per plant at planting time.

Lime

A pH of 6.0 is adequate to grow a good tomato crop and under our conditions it is impractical to try to go much higher. After initial breaking and liming, 1000 to 1500 lb per acre per year will maintain the pH around 6.0. The pH of native soil in the Wapenamanda area is 4.8 to 5.2. Lime is available locally and can be used without further processing.

Fertilizers

The analysis of the fertilizers used is as follows:—

	N	P	K	Mg	S	B
Base	9.7	6.2	14.9	1.39	4.7	0.2
Side Dress	13.6	4.4	17.9	1.81	5.8	0.2

All figures are expressed as percentages of the various nutrients in 100 lb of the mix. In addition to the base, the mix contains 4 per cent by weight of Ess-Min-El (a trace mix from Amalgamated Chemicals).

The optimum level in our trials is—

(1) 3 lb base dress per chain row at planting, plus

(2) 1 lb side dress per chain row 1 month after planting, plus

(3) 1 lb side dress per chain row 2 months after planting.

Other levels of fertilizer (both higher and lower than these) have reduced yields.

Further trials will probably prove the value of higher proportions of phosphorus. The value of a small amount of boron has been proved, but the optimum level has not yet been established.

VARIETIES

Of the many varieties available, 24 have been compared for production and disease resistance using the procedures outlined in this paper. Most have been compared at least twice. A few have proved consistently inferior. They are Marion, Red Cloud, Epoch and Grosse Lisse-45. Further work is required on Grosse Lisse and College Challenger. One of the big opportunities in improving production is to increase the percentage of saleable fruit. Some of our early trials had up to 70 per cent non-saleable fruit. "Non-saleable" here means not acceptable to our local vegetable marketing agency, WASO Ltd, Wapenamanda. This is for a variety of reasons, including small fruit, misshapen fruit, insect damage, soft spots from Blossom End Rot and soft spots from a variety of fungus and bacterial diseases. The largest percentage of non-saleability used to be from damage by Blossom End Rot. This problem has been largely solved by attention to proper calcium levels. Currently all of the above reasons contribute equally to non-saleability and about 30 per cent by weight of all fruit continues to be non-saleable. The yields of saleable and non-saleable fruit in a recent trial are shown in *Table* 1. All were transplanted outside on 1st July, 1970. The harvest period was 16th September to 12th November, 1970.

Hybrids

All the hybrids we have tried have proved inconsistent in production and require a high level of fertilizer and management to get good production. I would not recommend them for inexperienced growers. They could have merit for commercial producers, but they still require further testing.

PESTS AND DISEASES

The two major problems experienced to date are cutworms and tomato fruit worms. Cutworms will cut seedlings off at ground level during the first few days, but can be controlled by spraying a ring around each plant on the ground after planting. Use a 0.18 per cent DDT solution.

Good general control for tomato fruit worm plus several other worms can be obtained by weekly sprayings of DDT plus a spreader activator (both according to directions) until fruit set. After fruit set, Malathion should be used instead of DDT. We find it necessary to use the Malathion at higher than recommended rates to obtain good control.

Fungus and Virus Diseases

Much more work needs to be done to find the most effective ways of reducing the incidence of, and damage from, Anthracnose, Target Spot and Fusarium Wilt. We have compared Zineb, Difolatan, Maneb, Kopi, Dithane M-45 and Phaltan.

For our purposes, Maneb has proved the best and most economical. Phaltan did a good job but is more expensive than Maneb. Difolatan also did a good job while all the others mentioned were inferior. It is quite probable that further trials will alter the above statements. The fungus picture is complicated by variety resistance, plant nutrition and incidence and distribution of rainfall. We have included Captan 83, Ziram 90 and microtomic sulphur in current trials.

Blossom End Rot

This is a physiological disease that deserves special mention. We have found that during the wet season an increased calcium level in the soil will give a reduced incidence of Blossom End Rot. This situation seems to reverse during a severe dry season.

Crop Rotation

In this area tomatoes require special care. A small disease or insect buildup will very quickly reduce yields. Our present rotation of root crop—legume—tomato (or other vegetable)—root crop has given satisfactory results.

STAKING AND PRUNING

Many methods of staking can be used successfully providing they allow for adequate support of a heavy fruiting plant well above the rain splash zone and also allow for adequate ventilation. Bunching (more than one plant per stake) may better utilize available stakes and will also facilitate spraying but care must be taken not to restrict ventilation.

Pruning properly will also help open up the plant to good circulation of sun and wind. We prefer the single stem system with all bottom leaves trimmed so that no leaves are touching the ground. A bottom-trimmed plant will grow taller than one not so trimmed and put the majority of the fruit above the rain splash zone. We also recommend pinching out the lateral growth as soon as buds appear in the axils of the leaves.

CROP HYGIENE

All weeding is done manually by local women. To date no chemical weed control has been attempted. All plant residues of tomatoes are burned when possible, or buried in an area where there are no vegetable gardens. Residues of all other crops are fed to either cows or pigs and the manure (after composting) is returned to the gardens.

Table 1.—**Comparison of saleable and non-saleable fruit for different varieties**

Variety	Saleable Fruit per Chain Row (lb)	Non-saleable Fruit per Chain Row (lb)
Grosse Lisse	149	62
Manapal	213	80
Marion	129	105
VF-11	127	87

Practical Work for Students

Every agricultural college principal would like to have his college farmland in 'inspection-order' at all times. But if the first goal of the college—the education and training of students—has been displaced by the desire for orderly and successful farming, then the appearance is deceptive, for the college is a failure.

So writes Mr Gordon Dick, D.A.S.F's Chief Education and Training Officer in his paper, 'Practical Work in Sub-professional Courses in Agriculture', published in *Agricultural Education and Training: Annual Review of Selected Development*, FAO, 1971, pp. 24-28.

From his experience at both PATI and Vudal, Mr Dick outlines practical solutions to the problem of giving students the right amount and kind of practical work so that they gain the necessary experience without getting bored or frustrated and without sacrificing time needed for lectures and study. Students will never work happily if they think they are being used as cheap labour; they must feel that the project belongs to them. Or, as Mr Dick puts it, 'the drudgery goes out of weeding and digging if the success of the project belongs to the weeders and diggers'.

The article concludes with a description of the student projects at Vudal Agricultural College. Each final year student has his own research project, which helps to 'develop the student's awareness of the inter-relatedness of organisms and environment, his powers of observation and his initiative and self-reliance in meeting problems'. An article based on one of these projects appears on p. 139 of the last issue of *Harvest*.

A copy of Mr Dick's paper may be obtained from the Central Library, D.A.S.F., P.O. Box 2417, Konedobu.

The Meat Inspection Service

Everyone wants to be sure that the meat he buys in a shop is good food, not contaminated by any infection that will cause sickness to the person who eats it.

For this reason, the *Slaughtering Ordinance* 1964 lays down strict laws covering the slaughtering and handling of meat. These laws apply to all meat that is to be sold. Meat that is slaughtered under conditions which do not conform to the Ordinance must be given away, not sold. Slaughterhouses are licensed by D.A.S.F. and are supervised by qualified meat inspectors who ensure that all meat leaving the premises is of acceptable quality.

Plate I.—Stamping of beef at the Tiaba Abattoir near Port Moresby

The meat inspector's job starts with an examination of the animal before slaughter. Various troubles can arise while the cattle are being transported to the abattoir. If they are walked a long distance, there will be a considerable loss of weight. Even if they are taken by truck, there will be some loss of weight if the journey lasts several hours. There is always the chance of injury in transit, the main one being bruising. Pigs are especially subject to suffocation and there can be diseases induced by the journey (transit tetany, lobar pneumonia). So the inspector examines the animals before they are killed and animals showing any signs of disease or serious injury are removed immediately. After slaughter, the inspector looks for evidence of bruising or swelling, the state of nutrition of the animal, and the efficiency of bleeding. An examination of the carcass will reveal evidence of disease that was not detectable in the live animal. The head, visceral and body lymph nodes undergo marked changes in size, substance and colour if diseased.

The meat is handled and dressed under strictly controlled hygienic conditions, to guard against contamination by bacteria or insects at this stage. If the carcass is acceptable, it receives the official approval stamp, the number on the stamp indicating the slaughtering establishment. After leaving the slaughterhouse, the meat comes under the official control of the Public Health Department which ensures that it is transported and sold under conditions satisfactory to the community.

A Cheap and Durable Cattle Trough

A cheap and durable cattle trough can be made out of a 44 gallon drum, cut vertically down the middle, away from the bung.

The two halves are then arranged so that the bung of the original drum can be used as a plug of the trough for cleaning. The bottom of the drum is removed and the two halves are welded together and placed on cement supports. Next the inside of the trough is lined with chicken wire and tied with wire passed through holes in the drum. Finally the trough is plastered with a 2/1 sand/cement mixture.

It is safer to remove the bung and plug the hole with paper before plastering. This avoids the danger of forgetting about it and plastering over it, or of getting plaster in the screw-thread. To make doubly sure that the latter problem does not arise, a layer of thick grease can be applied to the thread before the paper is pushed in.

Piped water is needed, and a ball cock may be used to maintain the level of water in the trough. It facilitates cleaning if the ball cock is at the opposite end of the trough to the bung.

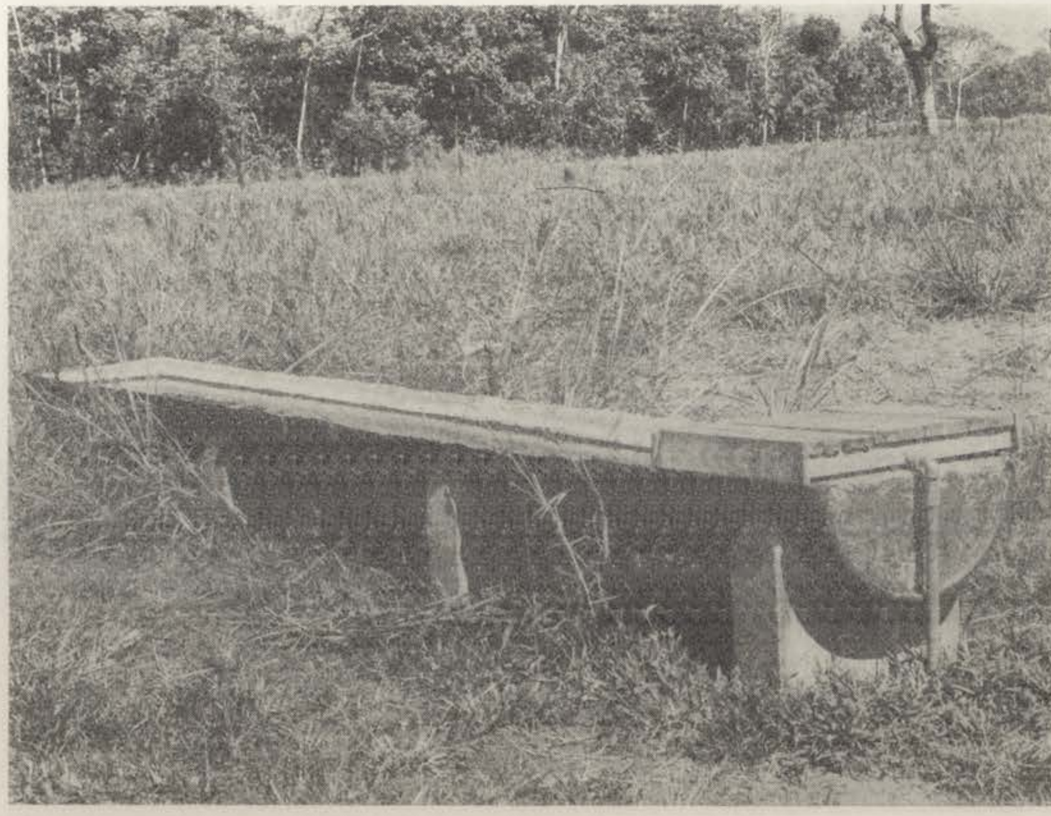
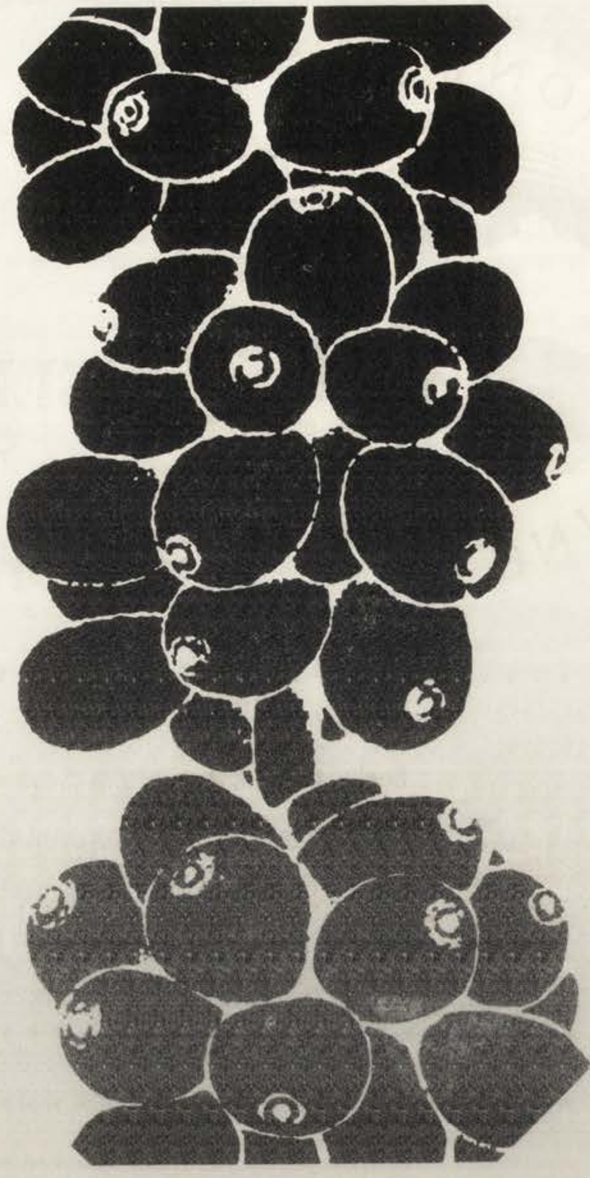


Plate I.—A trough made out of two drums



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