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Screening of Feeder Road Projects in Jamaica

By Amin Ebrahim and David Cox*

ABSTRACT

A recent feeder road improvement programme in Jamaica has been prepared by subjecting all candidate projects to economic evaluation. Using these results, it has been possible to investigate the reievance of the various input data, and make empirical predictions with reasonable confidence prior to the site visit. This paper describes the development and use of a screening method for the feeder road projects in Jamaica, using only the centralised information on population and agriculture that is available at the headquarters office.

I. INTRODUCTION

In 1984, the Ministry of Construction (Works) developed a new methodology for conducting economic evaluations of feeder road projects in Jamaica. The method is used to develop the Rural Roads Improvement Project. It involves comparing the potential benefits resulting from increased agricultural production and mobility benefits with the cost of road improvement. The information for benefits and costs is obtained from the field. Subjecting 171 projects to this methodology in 1984, 81 projects were shown to be economically feasible. Subsequently, 123 projects passed the project evaluation criteria out of the 270 projects considered in 1985. The evaluation of road projects in 1984 and 1985 resulted in a "pass" rate of about 47%. Thus, much of the evaluation effort in the field was unnecessary because of the more than 50% failure rate of the projects.

Until 1986, the field work was carried out on each project without any prior assessment of its probability of passing the economic criteria. Now, each project will be screened first in the office before it is subjecteed to the field investigation.

Information on population by Enumeration Districts and on cash crops by Extension Areas is available in the office. The population and cash crops data for each project is abstracted in the office using this information. This is the main information used in determining the project benefits. In Jamaica, the term cash crop refers to vegetable crops which are grown for home consumption and the domestic market, and which can be harvested in a short period of time, that is, normally within a period of 12 weeks. The term permanent crop refers to the main export crops and the information on permanent crops is obtained from the field. The main permanent crops in Jamaica are cocoa, coffee, pimento, citrus, coconut, sugar cane and banana.

The field work is carried out in two stages. The first stage is to determine the road improvement costs by driving over the road. The costs so derived by driving over the road are not accurate, and therefore, the costs in this stage are termed preliminary costs. At the same site visit, information relating to the permanent crop acreages and/or production, and that for the mobility analysis is collected. The second stage is to develop the detailed cost for road improvement by walking over the road for those projects which pass the preliminary cost stage. The 47% pass rate mentioned above, refers to the preliminary cost stage (first stage) of the evaluation. In this paper, the results from the screening tests are compared with the results from the preliminary cost stage. However, for readers' information, when the data from the detailed cost stage (second stage) is considered, the pass rate of the projects is only about 34%, that is, out of the 171 projects considered in 1984, only 58 projects were economically feasible.

In the early stages of preparing the feeder roads improvement project, lists of suggested projects were obtained from the Ministry of Agriculture, via their Land Authority Officers and from the Commodity Boards. Subsequently, the idea of a "universe" was introduced, this being a large selection of roads from which would be screened the best prospects for road improvements.

This paper describes the screening criteria for the feeder road projects from the "universe" using the information on population and agriculture available in the office to indicate the economic feasibility of a project based on the preliminary costs. It aims at making a prediction on the feasibility of the project, thus eliminating the need for the field work for the projects which are not expected to be economically feasible. The results show that with a prediction of the economic feasibility of a project in the office, we can capture 77% of the economically viable projects, but in the process we would lose 23% of the economically feasible projects. In so doing we will increase the pass rate of the projects in the study group by more than 25% to 59% from the current 47%.

The final result of the screening shows that if we are to look at 100 projects, we would expect 58 projects to fall above the threshold line (see Figure 1) and 42 projects below the line. Of the 58 projects above the line, 34 projects are expected to pass. It is suggested that no effort should be made on the 42 projects below the line since only 10 projects are likely to pass. Because we do not know which 10 projects will pass, we would have to consider all the 42 projects. The success rate from these 42 projects is unlikely to be worth the effort. On the otherhand, the effort on 58 projects above the line would give about 34 successful projects. The field effort on the projects above the threshold line is therefore justified. With only limited resources, the field effort on the projects below the threshold line should not be expended.

FIGURE 1

PROJECT SCREENING THRESHOLDS

POPULATION / MILE
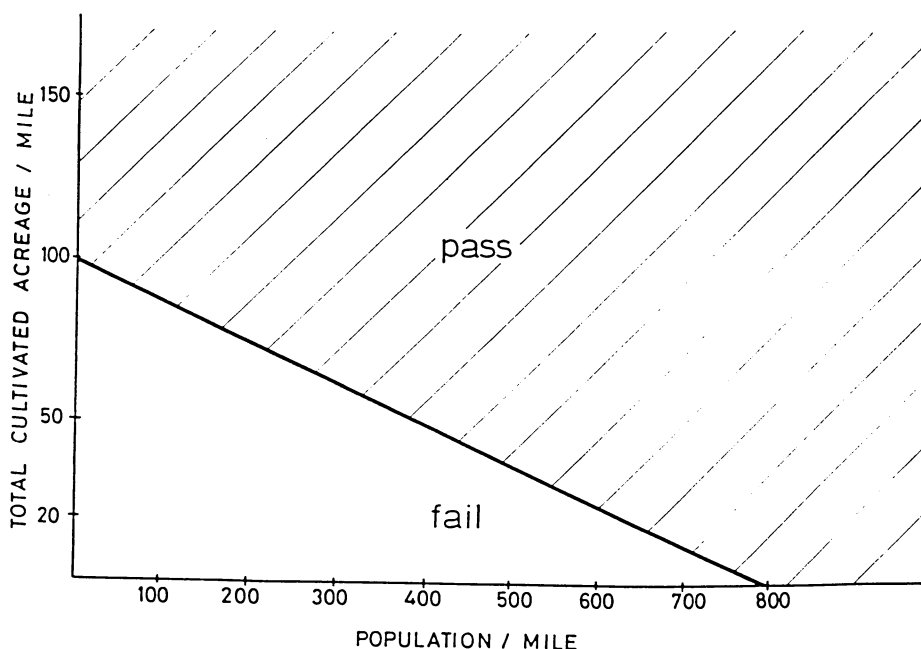
II. SCREENING—A BACKGROUND

Prior to the development of the screening criteria for feeder road projects in Jamaica, a review was made of other work in this area.

Vandervoort (1) states that "screening is not a superficial operation that can be done behind a desk". He states that each road needs a physical inspection before the road can be screened to be socio-economically viable or not. We agree partly with Vandervoort in that if sufficient information is not provided, screening cannot be done from behind a desk. We have accumulated in the office most of the relevant information that can determine the benefits accruable to the project. What is missing is the cost element and the information on permanent crops. The cost cannot be assessed by sitting behind a desk. But our experience in evaluating 441 projects has given us an adequate basis in estimating the costs for the projects. The information on permanent crops can be estimated in the office from the method shown in this paper. We do realise that in the process of screening, we will exclude 10% of the potentially viable projects. However, at the same time, we will eliminate the effort required to process 32% of the projects that are economically non-viable. The benefits of the screening method outweigh the cost of exluding the viable projects at least at this stage when the majority of 7,000 miles of feeder roads in Jamaica require improvement.

Weatherell's (2) screening method also needs a field visit to each road. It was for a particular ap-

plication and compared the value-added benefit from coffee or rice planting with the cost of improving and maintaining a road. It was developed for Liberia and is "appropriate only for use on an integrated development project where it is possible to make a firm assessment of the number of new farmers". Most of the feeder road improvement projects in Jamaica do not form a part of integrated agricultural development projects. Nor is there an influx of new farmers in many areas.

The Columbia (3) study identifies those projects that have very high costs or low benefits to eliminate them at an early stage of the process. However, it attempts to collect too much information at this stage—information such as terrain features, drainage works, earth moving, land distribution, production potential, community services, development plans, marketing, etc.

Therefore, it was concluded that the screening criteria for feeder road projects in Jamaica has to be developed independently of previous experiences primarily because

much field effort was being presently applied to projects which proved economically non-viable, when the overall planning resource was limited.

no integrated agricultural development effort is being undertaken in Jamaica;

the evaluation method for the feeder rural roads of Jamaica is a new concept, based on the increase in agricultural production

which is dependent on the present effort of the farmers and the predicted impact of the road improvement.

the information collected and analysis effort should increase as the project is processed through the screening stage, the preliminary cost stage to the detailed cost level, and not the other way round.

III. SCREENING

Screening, as described in this paper is the process by which a project could be predicted with some confidence to pass or fail. "Pass" here refers to the economic viability of the project and "fail" refers to the economic non-viability of the project. This prediction as shown in Figure 1, is made by checking the population per mile and the total acreage of crops per mile under cultivation in the influence area of the road. During the screening of the project, the prediction is made by using the information in the office. The screening exercise has two distinct advantages.

It makes the efficient use of the limited available resources. This is done by making field trips only for those roads which are more likely to pass. The opportunity cost of the two technicians who are in the field collecting information for each non-feasible project is realised since they would now be able to do productive work on the projects that are more likely to pass.

Jamaica has some 7,000 miles of feeder roads. A list of all projects with potential for passing the economic feasibility can easily be prepared by using the screening criteria. This could be done within a three-months study period.

IV. DEVELOPMENT OF THE SCREENING CRITERIA

Once identified, each project has the following information available in the office:

–length of the road
–road influence area
–population
–cash crop acreage
–road influence area covered by permanent crops
–types of permanent crops
–likely terrain

The so-called cash crops are vegetable crops which can be harvested in a short time. The permanent crops are the seven major export crops, namely, cocoa, citrus, pimento, coffee, coconut, sugar cane and banana.

A sample of 317 projects was taken out of the 441 projects evaluated in 1984 and 1985. Various parameters were taken to form the selection criteria, among them the population per mile, the permanent crop acreage per mile and the total acreage per mile. Terrain was also considered on the basis that the improvement costs in the mountainous terrain is expected to be significantly higher than the improvement costs in flat terrain. However, in the initial analysis, terrain did not turn out to be a determining factor, and therefore was excluded from further analysis. It was found that cost variation was the major factor in only 10% of all the projects studied.

V. SCREENING CRITERIA

After considerable analysis, the selection criteria of population/mile and the total cultivated acreage/mile proved to be convincing, logical and effective for the typical situation in rural Jamaica. The following equation for the pass/fail criterion emerged, which is shown graphically in Figure 1.

$$8y + x = 800$$

where   y = total cultivated acres/mile
            x = population/mile

Further analysis was carried out to determine the limits of this criterion. At one extreme, if the total of cultivated acres per mile exceeds 100 acres but has no population in the influence area of the road, the project is expected to pass. This is really an extreme case and none of the projects had absolutely no population living in the area. At the other extreme, if the road influence area has a high population concentration but minimal cultivated acreage, that is, if the population per mile exceeded 800 and the cultivated acres per mile was zero, the porject is again expected to pass. Again, none of the projects had such an extreme situation. As can be seen in Figure 2, most of the projects are concentrated within the ranges of up to 800 population per mile and up to 350 acres per mile.

Figure 2 shows the distribution of project feasibility with respect to population and total cultivated acres. It was this distribution which was used to arrive at the screening criteria threshold. When conducting the economic evaluation of a project, the population per mile and cash crop acreage per mile under cultivation are estimated in the office. But it should be noted that although the information for cash crops can be abstracted in the office, the data for permanent crop acreage is not available in the office. The permanent crop acreage is normally obtained in the field from the respective Boards, for example, the Banana Board.

VI. TESTING THE SCREENING CRITERIA

Testing was done in two stages. The first exercise was to use, for the 317 projects under study, the project feasibilities using the actual permanent crop acreages that had been obtained from the Boards during the field visit. The second exercise involved feasibility predictions, for the same 317 projects, using the predictions of the permanent crop acreages.

The following results shown, in Figure 2, were obtained from the first exercise.

Analysis of 317 Project Feasibilities

	Pass Projects	Fail Projects	Total
Above threshold line	117	48	165
Below threshold line	25	127	152
Total	142	175	317

By screening the feeder road projects in this way, we would effectively exclude 152 failed projects which fell below the threshold line. In so doing, we would exclude 25 economically viable projects which fall below the threshold line. Thus, if we were to start

with 317 projects, 25 or 8% of the economically viable projects would be excluded due to the screening. If we were to use this threshold line for screening, we arrive at the following conclusions.

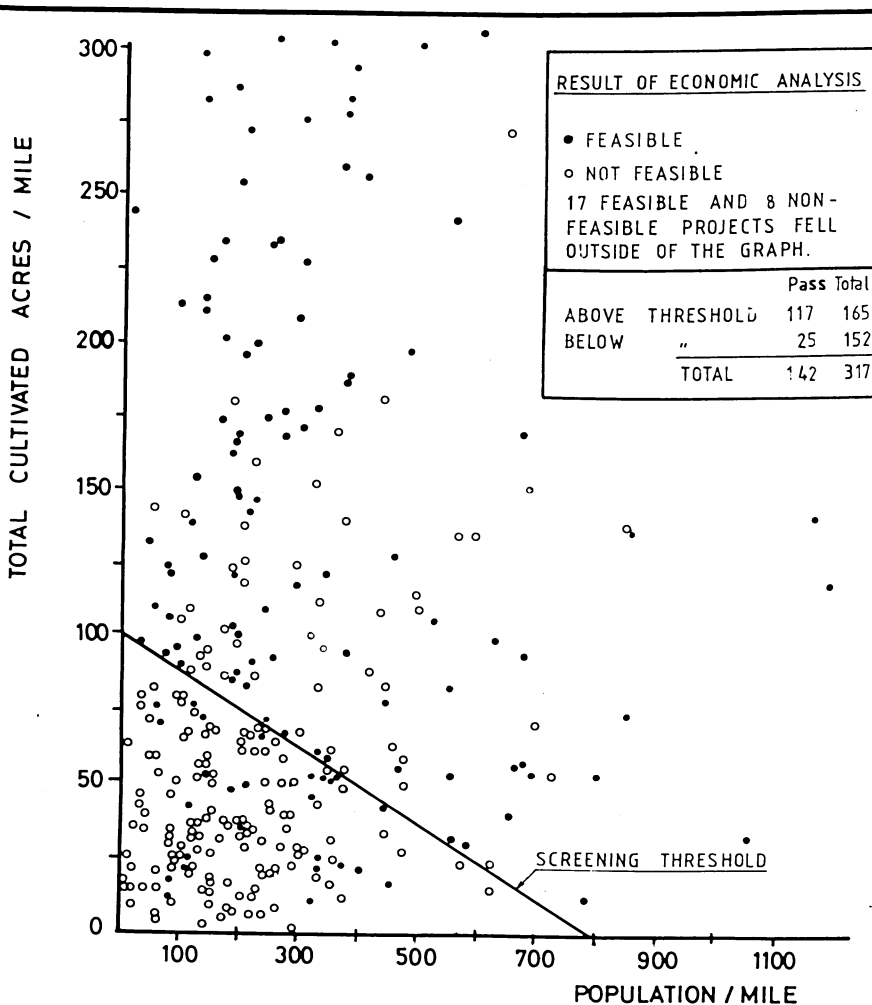77% of the projects could be correctly predicted

8% of the viable projects would be excluded

40% of the non-viable projects could be excluded

the field effort could be reduced from the current 100% to about 52%, that is, out of 100 projects being considered, some 50 would be looked at.

FIGURE 2

DISTRIBUTION OF PROJECT FEASIBILITY WITH RESPECT TO POPULATION AND CULTIVATED AREA

RESULT OF ECONOMIC ANALYSIS

• FEASIBLE
○ NOT FEASIBLE
17 FEASIBLE AND 8 NON-FEASIBLE PROJECTS FELL OUTSIDE OF THE GRAPH.

	Pass	Total
ABOVE THRESHOLD	117	165
BELOW "	25	152
TOTAL	142	317

SCREENING THRESHOLD

In the above exercise, the permanent crop acreage under cultivation was obtained from the field and then used in the screening.

Proceeding to the second stage of testing, an exercise was undertaken to make a prediction by the use of an estimated permanent crop acreage under cultivation. This is because, for a feasibility prediction using Figure 1, the total cultivated acres in the road influence area of the project is required. Total acres are comprised of cash crop and permanent crop acres. Cash crop information can be abstracted in the office, but the permanent crop information cannot, thus this information has to be estimated. This estimation of the permanent crop acreage was done in the office.

VII. ESTIMATION OF PERMANENT CROP ACREAGE UNDER CULTIVATION

Maps of Jamaica were obtained from the respective boards showing the areas where each of the seven permanent crops are to be found. A master map at 1:50 000 scale was prepared showing the areas for all seven crops.

A project's influence area drawn to the same scale on a transparent paper was overlaid on the map to determine which permanent crops are likely to be grown in the project's influence area, and how much of the influence area is covered by these permanent crops. This does not mean that all the permanent crop area falling under the influence area is under cultivation. Thus, having obtained the permanent crop that are likely in the project's influence area, the next step is to determine how much (or what percentage) of the permanent crop area failing in the influence area is under cultivation. This in effect is equivalent to determining the amount of permanent crop acreage under cultivation.

To determine this, the same concept was considered as, used in the Feeder Road Improvement Project Methodology for Jamaica. This hypothesis suggests that the farmers who are presently putting in the most effort are most likely to produce more in the future. thus, those farmers who produce more cash crops would also produce more permanent crops. In other words, those small-holder farmers who cultivate more cash crop acres would also have the greater total acres under cultivation. Figure 3 shows the empirical relationship of cash crop acreages under cultivation per capita to the total acreages under cultivation per capita. Actually, we know that there is a direct relationship between the population in a road influence area and the farmers in that influence area. Out of every 100 households (of an average size of 5 persons each), 72 households are likely to be farmers. Therefore, whether we use population figures directly or convert them to the number of farmers, we come to the same result. Figure 3 shows that a project in which the cash crop acreage per capita is high will have a higher total acreage per capita under cultivation than a project with a lower cash crop acreage per capita.

Under this basis to determine the total acreage per population, and then predicting whether the project would pass or fail by applying the project threshold line given in Figure 1, we obtained the following results for the 317 projects under study.

Results of the Feasibility Predictions

	Pass Projects	Fail Projects	Total
Above threshold line	110	75	185
Below threshold line	32	100	132
	142	175	317

These results are shown in Figure 4. If we are to analyse these results the same way as we analysed information from Figure 2 (using the actual information from the field), we come to the following conclusion.

67% of the projects should be predicted correctly

10% of the potentially viable projects will be excluded

32% of the potentially non-viable projects will be excluded

the field effort will be reduced from the current 100% to 58%, that is, out of 100 projects originally being considered, only 58 will now be looked at.

Obviously the screening of projects by this method reduces considerably the effort that is being currently placed on the economically non-viable projects; and the results from the feasibility predictions are not too far out when compared to the results from the project feasibilities.

VIII. DATA RELIABILITY

1982 population figures and maps of all the Enumeration Districts of Jamaica are now available in our office. Similarly, population growth factors for each of the thirteen Parishes of Jamaica are also available.

The Ministry of Agriculture Data Bank provides us with quarterly returns of cash crop acreages from the 400 extension officers covering the whole of Jamaica. Maps of all extension areas and names of all the officers are available. Detailed breakdown of planted acreages and yields for 52 cash crops for each extension area are also kept by our office.

In computing the population and cash crop cultivated acreages, we have assumed a homogenous distribution of population within each enumeration distict and a homogenous distribution of cash crop acreages within each extension area.

The Ministry of Agriculture Data Bank does not hold acreage and yield figures for the permanent crops of coffee, cocoa, citrus, coconut, sugar, banana and pimento, these being either tree crops or long term plantings. For these crops, the production figures are held by the respective boards or processors, who in general have very good information about the quantities they receive at the factories, but not about the exact sources. They often use postal agency addresses for payment purposes, which usually indicates the grower's location. Normally a registered buyer serves an area that is accessed by several feeder roads. Thus, some proportion is made by us based on verbal advice at the project site, to estimate the present levels of production in the influ-

ence area of a particular road. There is no doubt therefore that, even from the field, the permanent crop data is the least accurate.

For the screening of the feeder roads, the same population and cash crop acreage information is used, as is later considered in the preliminary evaluation. However, for the permanent crops, the maps of Jamaica showing areas of permanent crops ob-tained from the various boards are used. These maps cannot tell us exactly howmuch of the permanent crop acreage is under cultivation in each area. Thus we have developed Figure 3 to estimate the total crop acreage under cultivation (and therefore the permanent crop acreage under cultivation) by considering the effort currently being applied by the people on the production of cash crops.

FIGURE   3

RELATIONSHIP   OF   CASH   CROP   ACRES   TO

TOTAL   CULTIVATED   ACRES

$$TC = 0.25\,CC + 1.25\,CC^{0.47}$$

TOTAL CULTIVATED ACRES / CAPITA (TC)

CASH CROP ACRES / CAPITA (CC)
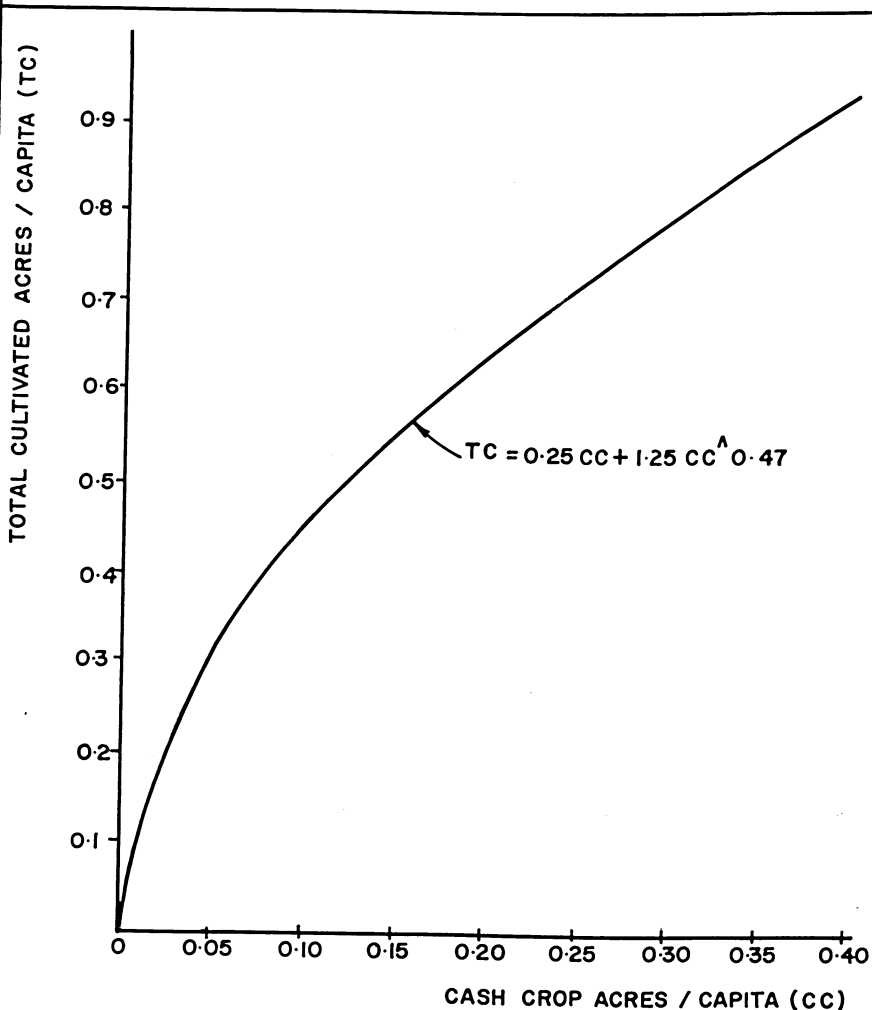
IX. A WORKED EXAMPLE

This worked example is meant to show how the screening of feeder roads projects is going to be used. Project No. AND020 is the road from Mt. Friendship to Mt. Dakin in the parish of St. Andrew. The project has a length of 2.64 miles.

The project's influence area was drawn using the definition that the area of influence extends to a distance of 1 mile from the road, or halfway between the road under consideration and the adjacent road. This distance is always less than 1 mile (see Figure 5). Then the area of influence is drawn to meet the two ends of the road project. Thus we get the project's road influence area to be 838 acres.

By superimposing the project's road influence

FIGURE 4

DISTRIBUTION OF FEASIBILITY PREDICTIONS TO BE
COMPARED WITH FIGURE 2

RESULT OF PREDICTIONS

● FEASIBLE

○ NOT FEASIBLE

13 FEASIBLE AND 3 NON-
FEASIBLE PROJECTS FELL
OUTSIDE OF THE GRAPH

	Pass	Total
ABOVE THRESHOLD	110	185
BELOW "	32	132
TOTAL	142	317

SCREENING THRESHOLD

TOTAL CULTIVATED ACRES / MILE

POPULATION / MILE

FIGURE 5

• LOCATION OF INSET

PROJECT- AND /020

MT. FRIENDSHIP -
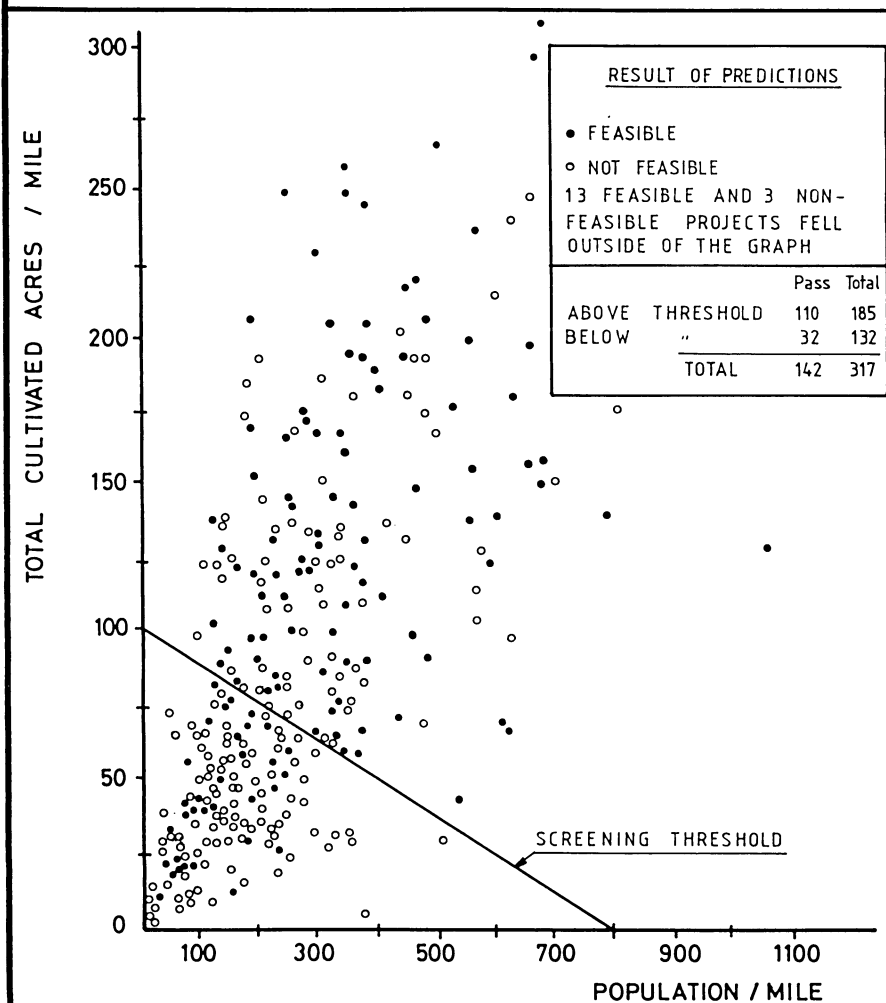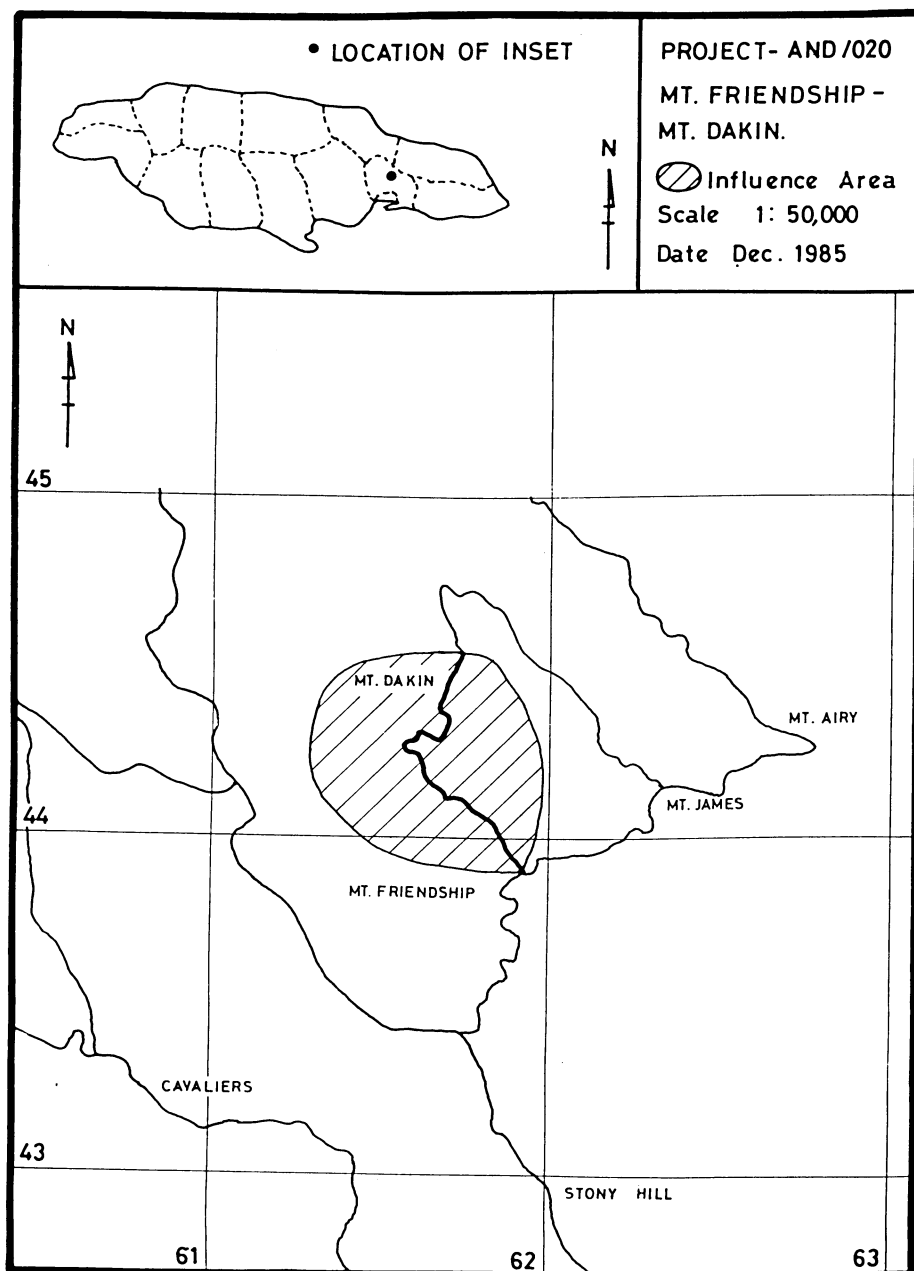MT. DAKIN.

N

⬭ Influence Area
Scale 1: 50,000
Date Dec. 1985

area on the population Census Districts, we see that 896 people live in the area. Similarly, by superimposing the road influence area on the extension areas we find that the project has 34 types of cash crops grown on 24 acres. By superimposing the road influence area on the permanent crop maps, we find that the area is likely to grow three permanent crops—coffee, cocoa, and pimento. (For readers' note, the field information indicated that, in fact, there were six permanent crops, coffee, coconut, citrus, banana, sugar cane and cocoa with 63 acres). The cash crop acreage per capita is 0.027 which gives us, by

using Figure 3, the total predicted acreage under cultivation to be 0.235 acres pe capita or 210 acres. We find by the application of the equation of the selection criteria that total acreage under cultivation per mile is 80 and population per mile is 340. Since $80 \times 80 + 340$ is greater than 800, the project is predicted to pass, and actually it did.

X. RECOMMENDATION

The screening criteria assists in making the prediction for a project to pass or fail. The result of this prediction is that only 58% of the projects will need field work in the first instance, thus reducing the current field effort considerably, but in the process about 10% of the potentially viable projects will be overlooked. The following method is suggested for the screening of future project proposals as depicted in Figures 1 and 3, which leads directly to a pass/fail prediction that is represented by:

$$800 \quad = x + 8y \quad \text{(Figure 1)}$$
$$= x + 8\,(0.25z + 1.25\,z^{0.47}) \quad \text{(Figure 3)}$$
$$= x\,(1 + 2z + 10z^{0.47})$$

where x = population per mile

y = total cultivated acres per mile

z = cash crop acres per capita

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jects", USAID Program Design and Evaluation Methods Report No. 2, January 1984.

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ACKNOWLEDGEMENTS

ENDNOTE

* Both authors are members of the Road Planning Unit (RPU) of the Jamaican Ministry of Construction (Works). Mr. Ebrahim is a consultant to RPU in the area of transport economics and is on leave of absence from the Federal Government of Canada. Mr. Cox is a Jamaican civil servant who developed the initial screening of feeder road projects under the direction of Mr. Ebrahim.