TECHNOLOGY ADOPTION: CULTURAL AND SOCIOLOGICAL CONSTRAINTS

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INTRODUCTION

Increasing worldwide concern with the possibility of large scale food shortages and the concomitant recognition of the need to raise standards of living of small farmers in developing countries, stimulated investigations of ways to increase agricultural production.

Among these efforts were the development of new agro-technologies, institutional and organizational arrangements, land reform, credit and extension.

The continued failure of development of the small farming sector has led to increasing concern that agricultural technology has not been adequately benefitting the world's small farmers.

Why this occurs has been the subject of a large body of literature. Some argue that the farmers are at fault. They are so traditional they do not want to change their habits, thus they reject attempts to the change in their technology. Another argument is that research and extension institutions are producing technology which is not appropriate to the conditions of the small farmer. Others argue that inputs are not available on a timely basis.

While these explanations might have some validity, the premise on which they are based ignores many factors that impact on technology adoption. The conventional approach to technology development utilising a 'top down' approach ignore the human element, the farmer.

The current pressure of burgeoning world supplies have thrown into relief the need for more economic responsiveness and the more rapid adoption of available new technology if the race is to be won.

This paper examines the cultural and sociological constraints to technology adoption among Jamaican small farmers. Firstly, we give a definition of technology and an overview of the role of technology in economic development. Secondly, we examine the theoretical approaches to the study of technology adoption. Thirdly, we examine factors affecting the adoption of technology in Jamaica with reference to available data.

THE CONCEPT OF TECHNOLOGY

The word technology was coined in early modern times about 1777 to convey the sense of a new movement for organising science in the service of man. By the early nineteenth century it meant 'providing the physical means of achieving democratic objectives of political society and economic quality'.[1]

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[1]Montgomery, J.D. (1974): Technology and Civic Life-Making and Implementing Development Decisions. The MIT Press, p.17.

Technology and consequently technological diffusion have been conceptualised in a number of ways each of which suggests different theoretical and historical approaches. The simplest version views technology as involving only changes in artifacts. A more sophisticated approach adds the physical objects, labour and managerial skills. A third approach views technology as a socio-technological phenomena; that is besides involving material artifacts improvements, technology is considered to incorporate a cultural social and psychological process as well as in this view any detailed changes if it is to be affective and the ultimate repercussions anticipated must be related to central values of culture.[2]

There are three categories, the sum of which are the substance of technology. These are techniques, tools and machines. In any discussions on technology, one necessarily deals in terms of one or a combination of these three factors.

A tool is a physical object, usually simple in structure which has been designed to aid in achieving some cultural end. It is subject to some standard procedure or techniques in its employment.

A machine is a complex device. It is a system of reciprocally and dynamically interacting parts, designed to carry out a function or a series of functions, and in the process is capable of taking over some of the tasks providing its own guidance in the delivery of energy, carry out repetition of action.

A technique, on the other hand, differs markedly from either of the foregoing two. Techniques are exclusively social and psychological in nature. Techniques are social prescriptions or procedures for carrying out any and all types of cultural functions. They may serve as an interface between humans and tools with a social fabric that confers upon them direction, guidance and a special meaning within the context of culture.[3]

The argument being advanced by Hetzler is that in most cases where tools and machines are found actively employed within a society, they become social extensions of human beings who employ them. As such, they may be classified as actors, having a capability for carrying out a social role. The role is determined by the types of functions which a machine has been built to perform; and a machine's acceptance and status within a society will depend upon the consonance between its role-playing and that society's present socio-technological system.

Historically, technology has set limiting conditions for civilisations, first by making advances in agricultural products and in recent centuries in laying the groundwork for industralisation and the rise of bougeois man.

The problem of how to increase the rate of economic growth in the less developed countries has led to increased interest on the part of economists and social scientist in the diffusion of technology from one nation to another.

A review of the literature on the transfer of technology reveal that the slow diffusion of technology is not only a feature of under-

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[2]Spencer, D.L. and Woroniak, A. (1967): The Transfer of Technology to Developing Countries. Praegar Publishers.

[3]Hetzler, S.A. (1969): Technological Growth and Social Change: Achieving Modernization. Rouledge and Kegan Paul.

developed economies whose inhabitants exhibit features of traditionalism. During the eighteenth century, the speed at which the diffusion took place in Europe was relative to a select geographic area and to very small technical changes. In fact Italy lagged behind other countries in the development of a machine tool industry in 1808.[4]

These observations automatically lead to the questions why? Why are some innovations transferred faster than others? Why are they diffused at different paces after being transferred? And most important of all, why are some group leaders in the area of technology adoption while others lag behind?

Explanations ranging from relative factors endowments to social rigidities have been given in answer to such questions but the importance attached to specific casual factors tend to shift from one case study to another.

What is apparent is that the success of technological change is contingent upon the ability of economic system to support them.

Economists have traditionally considered four factors as relevant to technological innovation and diffusion, these are: the general rate of economic growth, resource availability, labour availability and government action.

While these factors are relevant, this framework of analysis is limited because it ignores the socio-cultural context in which technology adoption takes place.

SOCIAL AND CULTURAL OBSTACLES TO DEVELOPMENT - A REVIEW OF THE LITERATURE

There are two themes arising out of modernisation theory that have commanded considerable attention. The first, is the notion of social and cultural barriers attempting to explain why it is that certain groups resist change and are conservative in their attitudes towards economic development. The other takes up the opposite problem of identifying the social and cultural factors that facilitate economic 'take-off' or function as structural prerequisites for the emergence of 'modern' socio-economic system.[5]

A major exponent of the cultural obstacles approach to the problems of development is Foster (1962). From studies in Mexico, Foster found strong evidence that peasants expoused a conservatism and lack of interest in exploiting new social and economic opportunities. According to this interpretation, peasants perceive their social world in terms of a competitive game in which one's gains are always to the expense of somebody else. Because of this they will tend to withdraw and not avail themselves of new opportunities for fear that this will lead to increasing socio-economic inequalities and to internal conflict. From this, Foster developed the idea of the 'limited good' translated to mean concern for security and community equilibrium.[6]

Taking cognisance of the fact that other obstacles exist, critics

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[4]Spencer, D.L. & Woroniak, A. Op. cit., pp.6-29.

[5]Long, N. (1977): An Introduction to the Sociology of Rural Development. Tavistock Publication.

[6]Foster, G.M. (1965): Peasant Societies and the Image of the Limited Good. American Anthropologist.

of Foster's conceptualisation, among them Acheson (1962) concluded that the only lack of responsiveness on the part of peasants is basically due to 'limited goods' rather than constraints imposed on the behaviour by adherence to Foster's ideas of the 'limited good'.

A series of social, cultural and socio-pyschological characteristics have been attributed to peasants by Rogers. Peasant communities are characterised by mutual distrust, suspiciousness, evasiveness, lack of use of innovations, fatalism, low level of aspirations, lack of deferred gratification, limited perspective of time, familism, dependence on governmental authority, localism and lack of empathy.

While some of these features are evident in some societies, this characterisation cannot be accepted as universal as the geographical and historical development of peasant groups are not taken into account. In addition, no cognisance is taken of the specific social and physical environment of a given peasant group.

A series of variables have been proposed by social scientist and which are supposed to have a direct influence on the knowledge concerning innovations, the willingness to use them and their subsequent acceptance and adoption are: a) age, b) level of education, c) social participation, d) use of mass media, e) cosmopolitan orientation, and f) social status and wealth.

MacDonald, in his study of the differential acceptance and utilisation of innovations in Peru constructed an analytical model to include the following factors represented in Figure 1.

Acceptance and adoption of innovations was measured by their past and present use. Analysis was limited to the use of the cultivation of the main crops. Acceptance of innovation means that it was used once, while adoption is measured by continued use. The level of acceptance differed in the two areas, in the Andahuaylas region the level was low, only 10% of the comuneros had ever used the most widely known innovation fertilizer in his agricultural undertakings. In the Montaro region, however, the acceptance of innovations were higher. The so-called initial factors were shown to be positively related with knowledge about, and use of innovations.[7]

While there is evidence of traditionalism in relation to agricultural practices, few studies have examined the social, economic and physical environments of agricultural producers and his role as a decision-maker.

There are no homogeneous farming communities as far as the adoption of innovations are concerned.

Rogers and Sola (1972), classified three types of innovation decisions:

1. optimal decisions - one made of other individuals in the social system. However, optimal decisions may be influenced by the norms of the social system and group pressure. A peasant's decision to adopt chemicals and fertilizers is usually an optimal choice;
2. collective decisions - are those in which individuals in the social system agree to adopt or reject by consensus where all must conform on the decisions made.

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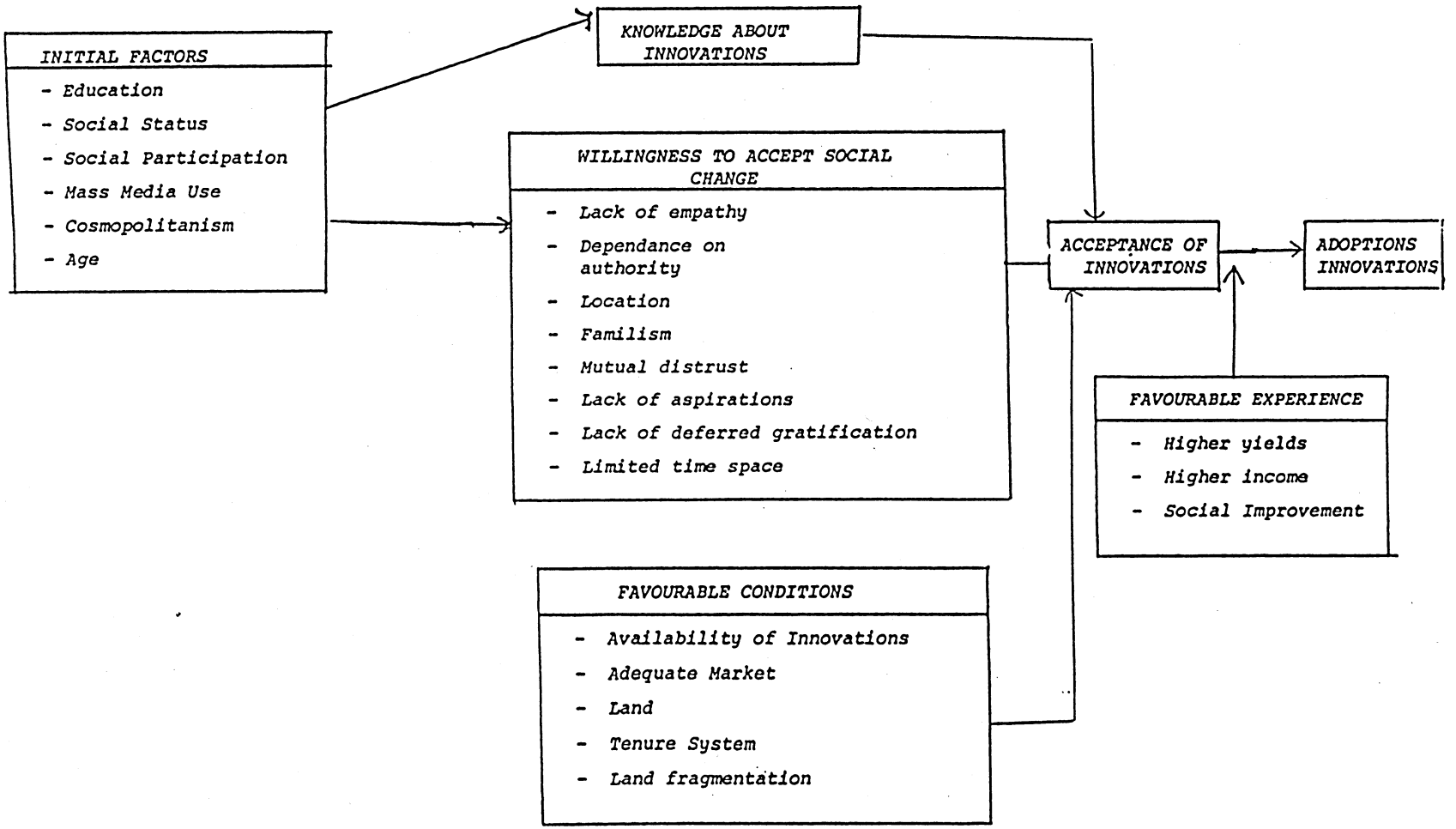
[7] MacDonald, A.L. (1972): Agricultural Technology in Developing Countries. Social Factors Related to the Use of Modern Technology in Two Rural Areas in Peru. Rotterdam Univ. Press.

FIG. I SCHEMATIC REPRESENTATION OF VARIABLES INVOLVED IN THE MODIFIED ACCEPTANCE/ADOPTION MODEL



TAKEN FROM MacDONALD, AGRICULTURAL TECHNOLOGY IN DEVELOPING COUNTRIES. p. 85.

3. authority decisions - imposed by someone in a super-ordinate power position. The attitudes and opinions of individuals towards innovation do not affect his adoption or rejection, he does what he is told. Few research studies have been done on this type of innovation decision, yet this must be the most commonly occurring type of decision.[8]

The continued failure to achieve sustained development within the small farming sector has led to new ways of generating knowledge about this group.

The systems approach is now being employed as the methodological approach to understanding agricultural systems. Central to this approach is the farmer, his resources and his decision-making practices. It has been recognised that a number of circumstances affect technology adoption. These are shown in Figure II.

The farmers' goals, income, food preferences, risk, resource constraints, land, labour, capital.

The market - for product inputs.

Institutions - land tenure, credit, extension.

The farming system - crop pattern, rotations, food supply, labour hiring. These have implications for the use of technology, time of application, method and amount used for each crop.

Ecological factors - such as climate, rainfall, biological, pest, disease, weeds, soil topography and slope, all affect technology adoption decisions.

Technological change occurs only when the innovation is actually adopted by the farm operators. Since the decision-making or choice context of the farmer is at the root of the adoption process, any new technological introduction or innovation must be viewed from the standpoint of the farmers.

Using micro-level data, Wharton analysed the influence of risk and uncertainty factors upon adoption of new technology. Wharton set out six sets of variables which are considered the most frequent reasons for the failure of farmers to adopt a new recommended technology.

The first three relate to the farmer:

1. not known or understood - the new technology may not be known by the farmer despite efforts of the change agent. The bulk of farmers may not have heard about the new technology;
2. not within the farmers' managerial competence - the farmers may have heard about the new recommended technology, but comprehension of what it can do or the effective utilisation of the new technology may require new knowledge and skill on the part of the farmers, which they do not have;
3. not socially, culturally or psychologically acceptable. A great deal is made in the development literature of those cases where a new practice or a new technique has not been adopted because it would upset too severely the established patterns of social or economic or political organization. A new planting or harvesting practice which is labour saving might eliminate the traditional labour service of wives or relatives;

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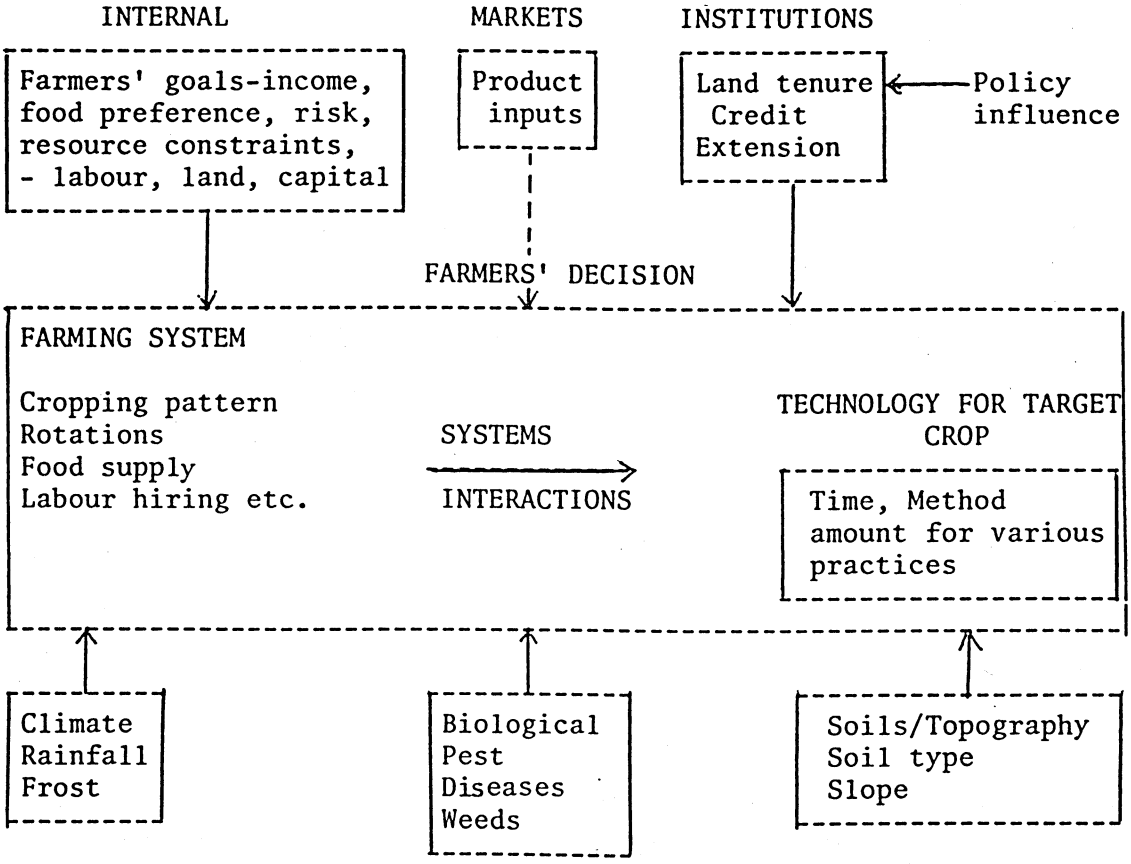
[8]Solo, R.A. and Rogers, E.M. (1972): Indicing Technological Change for Economic Growth. Michigan State Univ. Press.

FIGURE II: VARIOUS CIRCUMSTANCES THAT AFFECT FARMER'S CHOICE OF CROP TECHNOLOGY



---------- Circumstances which are often major sources of uncertainty for the decision maker.

Source: Human Organization, Vol. 42, Summer 1983, No.2, p.148.

4. the innovation - not technically viable or adequately adapted. Very often the new recommended technology has not in fact been locally adapted or tested under conditions which more closely approximate those faced by the farmer. If the new technology has not had adequate adaptation or if a small trial run on a 'demonstration plot' reveal that it is not a technically viable community resistance to the new technology quickly develops;
5. not economically feasible. Probably the most single cause of resistance to change is the non profitability of the new technology as seen by the farmers;
6. the externalities - notavailable. Often the new technology is embeded in physical titems such as seeds, pesticides, fertilizer or equipment. But unless the new item is readily

available to the farmer in quantities and at the time when he needs it, knowledge of its potential contribution to his agricultural production will not result in adoption. A fertilizer responsive seed might be available, but it will be of limited value to the farmers unless fertilizer is also available.[9]

The foregoing discussion reveal that the adoption of technology is affected by numerous factors. Among them, economic, social, cultural, socio-psychological and ecological. The factors relevant to Jamaican socio-economic context are now examined.

TECHNOLOGY ADOPTION - THE JAMAICA EXPERIENCE

The socio-technological characteristics of the Jamaican farming system has been adequately analysed by George Beckford who explains the plantation peasant dichotomy and the dualism in land use.[10] The predominance of the plantation sector whith its monocrop export orientation provided the focus of research and technology generation and adoption for decades.

The legacy of the plantation export production has resulted in the accumulation of a considerable body of technical knowledge, relating to the production of export crops, it is not surprising therefore that the level of technology in small farmer production systems tends to be much lower. These gross disparities in the levels of technology can be attributed to a number of sociological factors, these include age, education social and economic status, a cosmopolitan outlook and traditionalism, are all factors that influence the adoption of technology. [11]

The agro-socio economic survey in Portland reveal a number of constraints to the adoption of technology. The small size of farmers and their fragmentation militate against the use of machinery and advanced farming tools.

Examination of use of fertilizer reveal disparities in two areas of the parish. The non-use of fertilizer is more common in Buff Bay than is used in Portland. In the former, only 20% of respondents stated that they used fertilizer compared to 41% in the latter.

More than half of the farmers who do not use fertilizer in the Buff Bay area do not because they think it is not necessary ('the soil is fertile') they say. In Port Antonio area, the pattern is the same. Fifty-one percent (51%) of those who do not use fertilizer say they cannot affort it, while 21% say it affects the crops adversely. Only 19% felt that the fertility of the soil made fertilizer application unnecessary. Unlike the other two areas, 65% of farmers in Claverty Cottage area use fertilizer.

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[9]Wharton, C.R.: Risk, Uncertainty and the Subsistence Farmer. Technological Innovations and Resistance to Change in the Context of Survival.

[10]Beckford, G.L. (1972): Persistent Poverty Underdevelopment in Plantation Economies of the Third World.

[11]Baxter, A. (1975): The Diffusion of Innovations, Soil Conservation Techniques in the Yallahs Valley, Jamaica. Jamaica Journal, Vol.9, No.4, pp.51-56.

The pattern of use of chemicals for crop protection is similar to that of fertilizer use. In both areas it is a minority of farmers that use chemicals. Thirty-four (34%) and 14% respectively. Again the main reason given by the farmer is 'they cannot afford it'. As in the case with fertilizer use, over 50% of farmers in the Claverty Cottage area use chemicals to control weeds and pests. The most common reasons for not using the chemicals are 'there is no need', followed by 'they cannot afford it'. Other reasons outlined in all three areas are 'no government assistance', 'not available' and lack of knowledge.

Approximate farming practices is essential for successful agricultural development. The role of the (change agent) extension officers is critical in instructing farmers in proper farming techniques. Data available for the interim survey of the First Rural Development Project 1984, reveal the following results in relation to adoption of soil conservation techniques.

The number of farmers practising soil conservation techniques increased from 1981. Of the farmers interviewed, there was a 30% applying soil conservation techniques. The majority of farmers were on government lands of 5-10 acres.

The soil conservation measures most frequently adopted were hillside ditches, and individual basins used by 63% of farmers followed by the use of bench terraces by 27% of farmers using other methods. Ochard terraces, pasture with hillside ditches and contour barriers were evenly spread, averaging 3% each. Discussion reveal some resistance to change. This indicated the needs for further education. The data was examined to determine whether age influenced the decision to practice soil conservation. It was noted that 68% of farmers doing so were between 20-40 years and that the application of soil conservation techniques declined as age increased (see Tables I and II). However, it cannot be conclusively argued that age is a factor in the application of soil conservation methods - as the project focus was on farmers aged between 20-35 years.

Another variable studied was communication with extension agents. The data revealed that 80% of farmers had contact with extension agents. This showed a marked improvement over 49% in the baseline survey, 1981. Fifty-two percent (52%) of farmers who knew the extension officers had discussions with them fairly often or very often. Forty-two percent (42%) seldom or never. The majority of farmers reported receiving some form of assistance from the extension officers. The most frequent type of assistance was for land preparation. Twenty-four percent (24%) farm plans, 15% weed and pest control and planting 12% each. The data does show some form of communication between the extension agents and the farmers. There is unfortunately little evidence of an increased acceptance of new farming methods. It is also evident that contact with extension officers does not specifically influence the decision to practice soil conservation. For example, 35% of farmers who knew the extension officers practiced soil conservation. Sixty-five percent (65%) did not.

Farm Equipment

In this study, 7% of farmers reported usage of a farm equipment. Tractors were frequently used; one farmer had a knapsack sprayer and a

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12 Portland Interim Agricultural Development Plan (1983): Rural Physical Planning Unit, Ministry of Agriculture.

mist blower. All farmers using farm equipment occupied rented land. Although 20 farmers used farm equipment, 40 said they had access to equipment. If access in this context is meant ability to pay, then the gross value of production (an indicator of earned income) is not a determining factor. This is apparent because 17% of farmers with production value of less than $300, $2500 - $4000 and $7000 and over all had access to farm equipment. Tractors are the type of equipment most frequently rented and also the most expensive. Use of chemicals - 64% of farmers interviewed used some type of chemical and 85% used was fertilizer 85%. There was minimal usage of other chemicals.[13]

Among the factors which inhibit the adoption of new techniques is tradition. Among small farmers in Jamaica, technological conditions in which farming is based has remained virtually unchanged for generations. The static state of the art is reflected in the type of tools used (hoe, machete and fork) land clearing and soil preparation techniques. [14]

A preliminary review of Baseline Data from the Cropping Systems Project, 1985 reveal that tradition is a contributory factor to the non-use of fertilizer by farmers in St. Catherine. Among farmers not using fertilizer, 26% reported 'it was not necessary'. Five percent (5%) tradition, 11% high cost; 1% unavailability. Among the farmers reporting high cost, it was observed that these farmers used fertilizer. These could be termed 'dual farmers' (Wharton). These farmers used fertilizer on cash crops such as tomato, but utilised traditional practices with food staples such as sweet potato, yam.[15]

Data from the Two Meetings Pindars River indicate that farm size, land tenure are important factors in technology adoption. This is demonstrated in the adoption of soil conservation techniques. A very small percentage of farmers who owned less than two acres of land and none of those operating less than 1 acre farms practised soil conservation.

As farm size increases to 5 to less than 10 acres, more farmers apply soil conservation measures. Sixty percent (60%) of farmers using Bench Terraces were from the farm size group of 5 to 10 acres. Ten percent (10%) used Hillside ditches. Only two farmers operating land of 20 acres and over had soil conservation treatment. None of the farmers operating 50 or more acres of land used soil conservation treatments. This is related to two main factors. The larger farmers usually operate the flatter land which requires very little or no terracing. In addition, these large farmers were mostly involved in pasture for livestock and did not find it necessary to practice soil conservation measures.[16]

Another factor which inhibit the use of technology is infrastructural problems, which poses difficulties in getting the

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[13] First Rural Development Project (1984): Interim Survey Evaluation Branch, Ministry of Agriculture.

[14] Coke, L.B. and Gomes, P.I.: Caribbean Technology Policy Studies Project. ISER.

[15] Preliminary Result. Baseline Survey Jamaica Cropping Systems Project Evaluation Branch, Ministry of Agriculture, 1985.

[16] Baseline Survey - Second Integrated Rural Development Project, Pindars River and Two Meetings Watersheds. Evaluation Branch, 1979.

inputs to farm. One farmer explained that the time spent in transporting fertilizer to the farm was the major reason for not using fertilizer. The farmer appreciated the fact that fertilizer increased yield, but in order to get one bag of fertilizer to the farm, she had to walk up hill for one and half hours, a distance of approximately 5 miles. The time spent transporting the fertilizer reduced the time spent on other activities.

Perception of risks and uncertainty also inhibit agricultural producers in responding to available technology and market opportunities. Problems with pest and diseases, unfavourable weather conditions and praedial larceny are often cited as barriers to the adoption of certain enterprises. Although new seed varieties are available, farmers will resist them because they are not sure about the management practices. The main concern is security and survival.

Lack of knowledge about technologies is also a major factor which inhibit adoption of new technologies, numerous cases have been reported where the wrong mixture of pesticides were used which either killed the crops or was ineffective because of the wrong concentration had been used.

CONCLUSION

The results of available data indicate that cultural and sociological factors do inhibit technology adoption. The data is consistent with the models set out in this paper, to the extent that these problems constrain increased agricultural production in the face of growing food crisis, presents formidable problems for planners engaged in agricultural extension and rural development.

The small farmer through his inherited institutions and his traditionally determined socio-economic behaviour, had developed a strategy to win the basic struggle for survival. He will not relinquish this strategy easily. Assuring the farmer of the dependability of the new technology is the major challenge to us all.

TABLE 1: NUMBER OF FARMERS USING SOIL CONSERVATION TECHNIQUES ON THEIR FARM BY AGE

Age of Farmer	No. of Farmers
< 20	1
20 - 29	31
30 - 39	26
40 - 49	15
50 - 59	8
60	2

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[17]Gladwin, C.H. (Summer 1983): Contributions to Decision Tree Methodology to a Farming Systems Programme. Human Organisation. Journal for the Society of Applied Anthropology. Vol.42, No.2, pp.140-157.

TABLE II: NUMBER OF FARMERS BY AGE AND SIZE OF FARM USING SOIL CONSERVATION TECHNIQUES

Age of Farmer	Size of Farm								Total
	0.5	< 1	1 2	2 5	5 10	10 20	20 50	50	
< 20	-	-	-	-	1	-	-	-	1
20-29	-	-	-	-	2	29	-	-	31
30-39	-	-	-	-	2	24	-	-	26
40-49	-	-	2	-	2	10	1	-	15
50-59	-	-	-	-	4	4	-	-	8
60	-	-	-	-	-	1	-	-	2
Total	-	-	2	-	11	68	1	-	83