CRITERIA FOR TECHNOLOGICAL APPROPRIATENESS FOR RURAL DEVELOPMENT PLANNING IN TANZANIA

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ABSTRACT

This paper attempts to analyse the definition of technology concept of appropriate technology and the issues of technology choice for rural development in the developing countries. It has been observed that different scholars understand differently various concepts and definitions. As a result therefore inappropriate technologies have been chosen for rural areas of the developing countries. An attempt has been made in this paper to clarify the terms technology, appropriate technology and technology choice. In addition, a set of appropriateness criteria for choosing technologies which fit the surrounding of the user and also compatible to their resource endowments has been developed. The developed approach is illustrated using a real situation of the vegetable oil processing technology developed for rural sector of Tanzania.

INTRODUCTION

The random importation of technologies into the rural areas has not been successful in solving the problems of poverty and inequality in developing countries. As a result hundreds of millions of people still live below the poverty line and in many cases, introduction of imported technologies has resulted in a fundamental and a massive assault on local culture [1]. Therefore, the issue of technological choice with respect to rural development arose essentially as an effort to import, adapt, if necessary, the imported technology, and develop technologies appropriate for rural surroundings and compatible with their resource endowments.

The development of technologies suitable to the local conditions of the rural areas, has led to the coining of many terms such as "third world technology" by Mathur [2], "progressive technology" by Marsden [3],

"intermediate technology" by Schumacher [4], "appropriate technology" by Morawetz [5], "alternative technology" by Dickson [6], among others such as "grass roots technology", "kind technology", "barefoot technology", "evolutionary technology", "non-violent technology", "non-polluting technology", "soft technology", "indigenous technology", "self-help technology" and "green technology". The proliferation of such terms each coined to deal with very specific orientation of the analysts has led to considerable confusion.

However, a growing number of development experts and national policy makers now recognize that technological appropriateness is not an intrinsic quality of any technology, but is derived from the surroundings - technological as well as socio-cultural, politico-legal, economical and environmental - in which the technology is to be utilized, and the purpose of its application. Unfortunately, a set of coherent criteria based on such a concept is missing. It is imperative that both technology and appropriate technology terms be clarified prior to the development of the appropriateness criteria.

In this paper no attempt will be made to analyze and clarify the coined terms above. However, the definition of technology will be dealt first with a view towards providing the concept of appropriateness of technology The valuable findings of innovation diffusion research and the thought provoking ideas of appropriate technology research have been incorporated to identify the factors that govern the choice of a technology for rural development. A set of choice criteria which may be used in a "technology choice" situation has been developed. This approach is illustrated using a real life situation in the rural sector of Tanzania.

THE DEFINITION OF THE TECHNOLOGY

The literature on technology management abounds with numerous definitions of technology each focusing on the specificities of the situational context in which the term technology is being used. Some defined technology with respect to its generation, others focused on its application and some analysts looked on both generation and application. Technology, often related to machines and processes, or hardware and software, has recently been reported to consist of four interrelated components which take the following forms [7,8]:

* *Object-embodied form or "technoware"* - tools, capital goods, intermediary goods, products, physical equipment, machinery, physical processes, etc.,
* *People-embodied form or "humanware"* - understanding, capacity for systematic application of knowledge, know how, human capability, human labour, specialized ideas, skills, problem solving capacity, etc.,
* *Document-embodied form or "inforware"* - knowledge about physical relationships, scientific and/or other forms of organized knowledge, principles of physical and social phenomena, technical information, specifications, standards, computer software, etc.,
* *Institution-embodied form or "orgaware"* - organizational work assignment, day-to-day operations of production, social arrangements, means for using and controlling factors of production, organization of products, processes, tools and devices for use by people.

According to The Technology Atlas Team [8], all four components of technology are complementary to one another and are required simultaneously for the production of goods and services. Such production can never take place in the complete absence of any of the four components. Of course depending on the nature of the production activity, the relative importance of each of the four components may differ. The use of the four components of technology approach had been demonstrated in Bangladesh to illustrate the policy imperatives of the non-farm sector [9], and also in other Asian countries such as India, Korea and Japan [10,11].

Technology however does not operate in a vacuum. Its use takes place within an "operational" environment which may be called the technology climate. The technology climate of a country has been defined as the national setting in which technology-based activities are carried out [7] [8]. The climate includes factors as physical infrastructure; support facilities such as technological extension service and repair workshops; setting-up of the R&D institutions; and political systems at various administrative levels for regulatory, property rights, etc. The "climate" factors have been argued to be treated as endogenous to the development process, rather than as an exogenous factor that operates independently [12].

THE CONCEPT OF APPROPRIATE TECHNOLOGY

The meaning of the generic term "appropriate technology" has been often used synonymously with other terms as already pointed out. Unfortunately none of those coined terms on their own describe the kind of technologies that are most suitable for the needs of the poor anywhere in the world.The proliferation of such terms as pointed out is due to the lack of a coherent conceptual framework of appropriate technology. Jequier and Blanc [13] defined some of the above terms explicitly and a clear difference from one term to another was observed.

Consolidating the efforts made by various scholars in appropriate technology, it appears reasonable to state that, any technology is "appropriate", particularly at the time of development, with respect to the surroundings for which the technology has been developed, and in accordance with the objectives used for development.The technology may or may not be appropriate at the same place at a different time, because the surroundings and/or the objective may have changed. Similarly, the technology may or may not be appropriate at a different place at the same time or at different times, because the surroundings and the objective may be similar or different. Thus, technological appropriateness, is not an intrinsic quality of any technology, but is derived from the surroundings in which the technology is to be utilized and also from the objectives used for evaluation [14]. The appropriateness is, in addition, a value judgement of those involved in decision-making. Therefore, when appropriate technology is looked at in its broader terms, it takes into account the variations of the time horizon, place of operation, and the group which uses the technology.

According to this simple conceptual framework, any technology is appropriate at the time and place of original application.The technology is still appropriate at a later time and/or at a different place if the surroundings as well as the objectives are similar to the origin.The technology may not be appropriate at a later time and/or at different place due to three reasons:

1. different or changed surroundings;
2. different or changed objectives; and
3. different or changed surroundings and objectives

The surroundings differ not only from place but also over time.As a matter of fact, with the passage of time and application of technologies, almost all elements of the surroundings change, for better or for worse. But not all components of the surroundings such as population, resource, economic, environmental, socio-cultural aspects, etc., are relevant to every specific technology. What constitutes the surroundings depends upon the technology under consideration.

SOME PERSPECTIVES ON TECHNOLOGY CHOICE

Technology choice is defined as a problem of choosing from among a set of feasible technological alternatives [15].The feasible alternatives where a choice can be made are provided by technology assessment.As pointed out by Coates [16], technology assessment is a class of policy studies which systematically examines the effects on the society that may occur when a technology is introduced, extended or modified with special emphasis on those consequences that are unintended, indirect, or delayed. In order to undertake a technology assessment process, a set of acceptable appropriateness criteria must be available.

In analyzing the work of Sharif and Sundararajan [17] [18] and Riedijk [19], there seems to be an existence of three distinctive criteria levels. These include the criteria for assessing the national priority needs, followed by criteria for assessing the required type of industry, and eventually, the criteria for assessing alternative techniques or "brands".The three criteria could be renamed as "socio-economic development sector criteria" for assessing national priorities, "generic technology criteria" for assessing industry priority, and "specific technology criteria" for assessing a suitable specific technology. Figure 1 shows such categories of technology choice in the context of rural areas and their corresponding cascading criteria.

The first category of choice from the socio-economic development sectors is encountered when a country wants to realize a particular objective, for instance, accelerated rural development. Examples of such cases could be the prioritization of national needs. This would involve the evaluation of various sectors of economy, and among them are food, health, afforestation, energy, mining, and communication, for the purpose of rural development. Rohatgi and Rohatgi [20], and Sharif and Sundararajan [18] have made use of criteria C1 in Fig. 1 to choose sectors for socio-economic

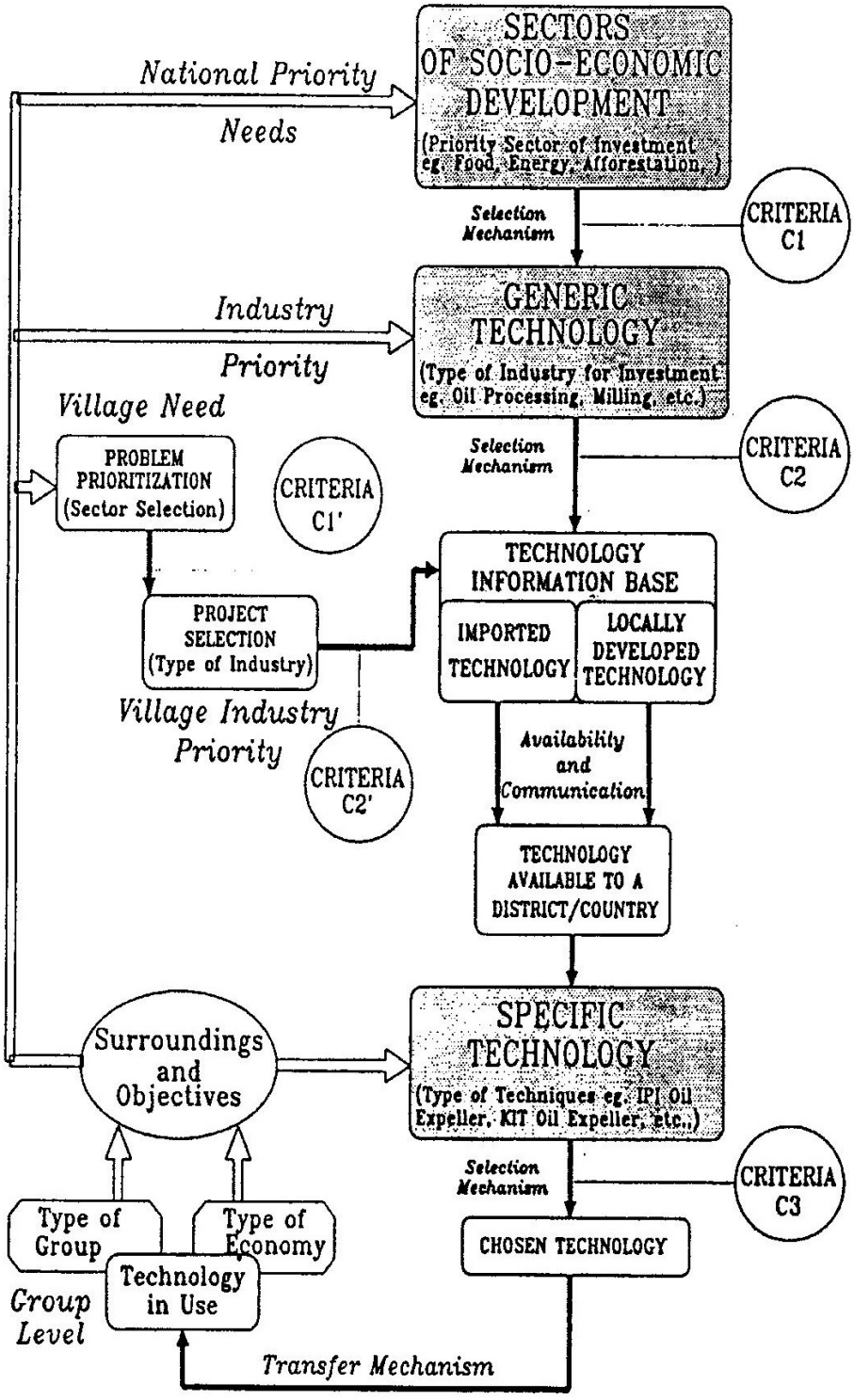

Fig. 1:Technology choice in a cascading process for rural areas

development.

The assessment of processes used for the fulfillment of a particular need fall in the second category of generic technology. This would involve evaluation of the type of industry which has to fulfil the need of the country Included are evaluation of vegetable oil processing, cooking stoves, milling, textile, industrial processes, which are all examples of such assessment. Forsyth et al. [21], and Sharif and Sundararajan [17] used criteria level C2 for choosing generic technology.

The third category deals with assessment of specific technology to best meet either the need of the group, or community, or the country at large. It involves assessment of the techniques or products. This includes the evaluation of the brand of technologies, for instance, the "Institute of Production Innovation (IPI)" oil expeller, the "Bielenburg" oil press, the "Japanese" oil expeller, the "Dutch" oil expeller, the "Indian" oil expeller, the "Komatsu" tiller, the "Caterpillar" bulldozer, etc. Various analysts, among others, have used criteria level C3 for choosing specific technologies [15,18,22,23,24,25].

However, a clarification is needed on the relationships between criteria C1', C2' and C1, C2 since criteria C1' and C2' have not been discussed. The criteria C1' and C2' might have similar evaluation parameters as those in criteria C1 and C2 respectively, but they differ in the level of administrative structure in application. In addition, they also have different decision makers. The criteria C1' and C2' will usually be used if the national planning machinery did not take into account the village surroundings and objectives. The national level therefore has to take these groups into consideration during the planning process, because the groups constitute the nation. The interaction between the national level and the village level on technology-based activities, have to be enhanced so that viable technological policies could be explored.

In this paper however, no attempt is made to discuss the details of the socio-economic development sector criteria and generic technology criteria. The focus of this paper is to provide technology choice criteria to assess alternative technologies from among specific technologies using the choice criteria C3 as shown in Fig. 1. The following section addresses the latter criteria C3 for choosing specific technologies.

DEVELOPMENT OF CRITERIA FOR TECHNOLOGICAL APPROPRIATENESS

Various scholars have presented different appropriateness criteria for choosing specific technologies for rural areas. These include, among others, Sharif and Sundararajan [18], Riedijk [19], Bowonder [22], Francis and Mansell [23] and Carr [26]. Rogers [27] has summarized factors for categorization of the potential adopters of innovations and the factors affecting diffusion of innovation. An attempt has been made to examine the appropriateness of technology based on the criteria presented by different scholars in appropriate technology and also the factors afecting technology adoption from the diffusion of innovation literature. One possible classification of such appropriateness criteria could be based on two sets of criteria namely, criteria to assess the technology climate and criteria to assess the attributes of the group that is expected to use the four components of technology (Fig. 2).

The criteria to assess the technology climate would include those which deal with the financing of the total cost of the technology. Such finance is usually provided by relevant financial institutions such as individuals (eg. farmers), village money-lenders and banks. In addition, the technology climate would also include criteria related to the supporting infrastructure and institutional services. In accordance with this classification, Sharif and Sundararajan [18] have reported the initial cost of the technology to be the "dominant factor" in technology assessment. The dominant factor as defined by them had a value of either one or zero for each technology depending on whether the alternative met or did not meet the minimum requirements with respect to the dominant conditions. Furthermore, they stated that any technology which had a dominant factor index of zero was excluded from further assessment consideration. Thus, the cost of financing the technology as illustrated in Fig. 2, is classified as first screening stage in the technology climate assessment. The supporting infrastructure and institutional services which includes extension staff, repair and maintenance facilities, and basic infrastructure could be then considered as the second screening stage in the climate assessment.

The supporting infrastructure and institutional services may be considered to reflect the social and technical aspects of the technology while the cost as a criterion reflects the economic aspects. The social aspects in the

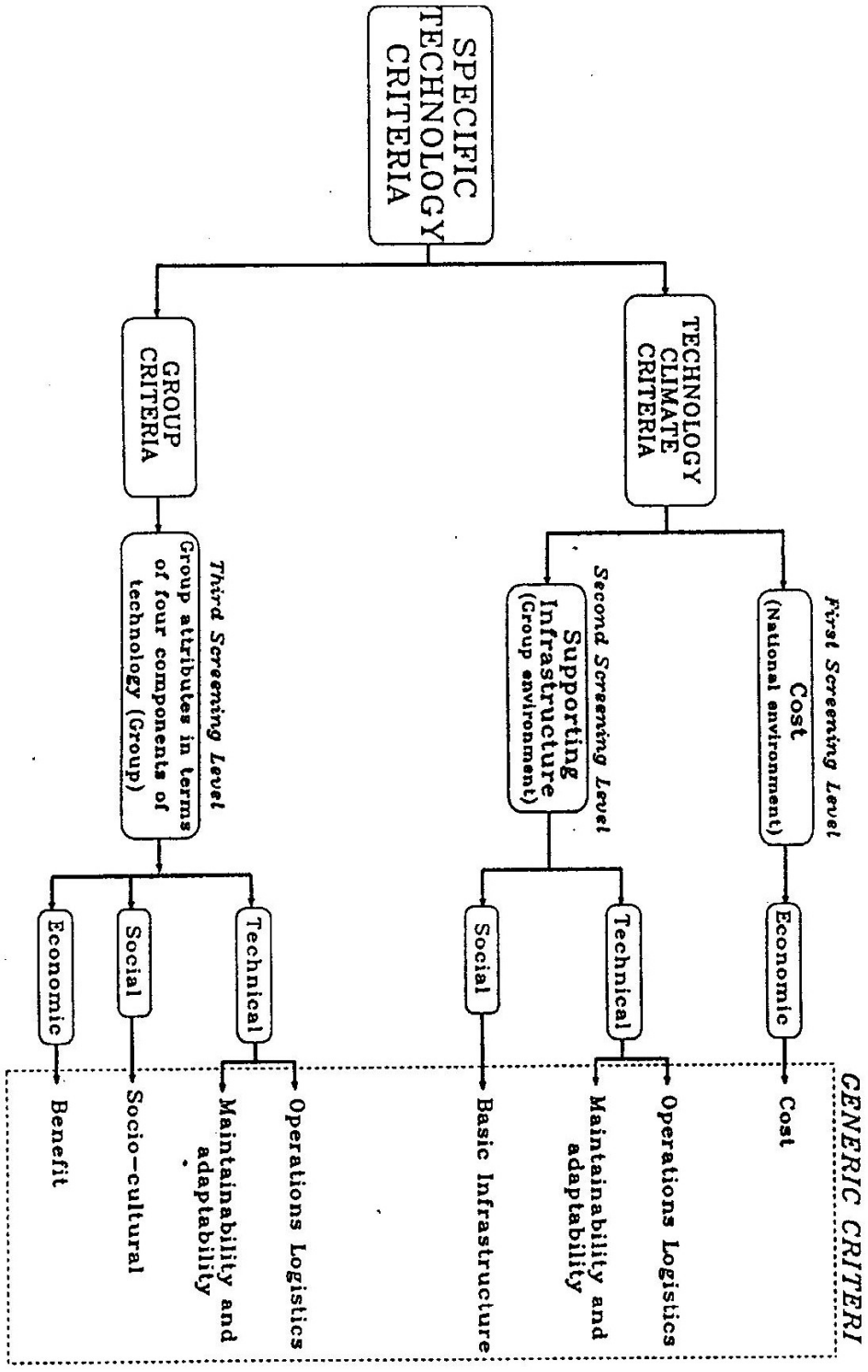

Fig. 2: Criteria development for assessing specific technology

technology climate include criteria which deal with basic services and infrastructure. The technical aspects deal with criteria related to operations logistics, and maintainability or/and adaptability.

The criteria to assess the attributes of the group that is expected to use the four components of technology could include technical aspects, social aspects and economic aspects. The technical aspects as already pointed out would include criteria to deal with operations logistics, and maintainability or/and adaptability. The social aspects include criteria related to socio-cultural factors of the four components of the technology The benefits gained from the use of the technology come under economic aspects. Therefore, the technology climate and the group using the four components of the technology would be assessed in techno-socio-economic terms.

The proposed three levels of appropriateness criteria need to be linked to the concept of appropriate technology. The concept of appropriate technology as pointed out is based primarily on the objectives and surroundings of the group which uses the technology. This means, technologies transferred to the rural areas have to be assessed in accordance with the objectives and surroundings of the users of the technology namely the group. To facilitate this assessment, the technology transfer framework developed by Schlie et al. [28], has been adapted for rural development by introducing a "feedback" linking mechanism. The "feedback" linking mechanism has been reported by various analysts to be a vital element in technology transfer for rural development [29,30,31,32].

The adapted framework of technology transfer for rural development, consists of seven elements namely, the transferor (source of technology), transferee (receiver of technology), the technology itself, linking mechanism, transferor environment, transferee environment, and a greater environment (in this paper is the national technological climate). The technology transfer framework for rural development is shown in Fig. 3. Therefore, when the concept of appropriate technology is mapped onto this framework of technology transfer, it can be seen that three levels of technological barriers, namely, the greater environment, the transferee environment, and the transferee have to be overcome before the technology can be effectively used. These levels from a national point of view are the national environment, group environment and the group itself respectively

These technological barriers would need an appropriateness criteria to assess the use of the technology by the receiving group. Therefore, the three screening levels of appropriateness criteria discussed above, that is, cost, supporting infrastructure/services, and the group in terms of four components of technology, provides the criteria to each technological barrier at the national environment, group environment, and group itself as shown in Fig. 4.

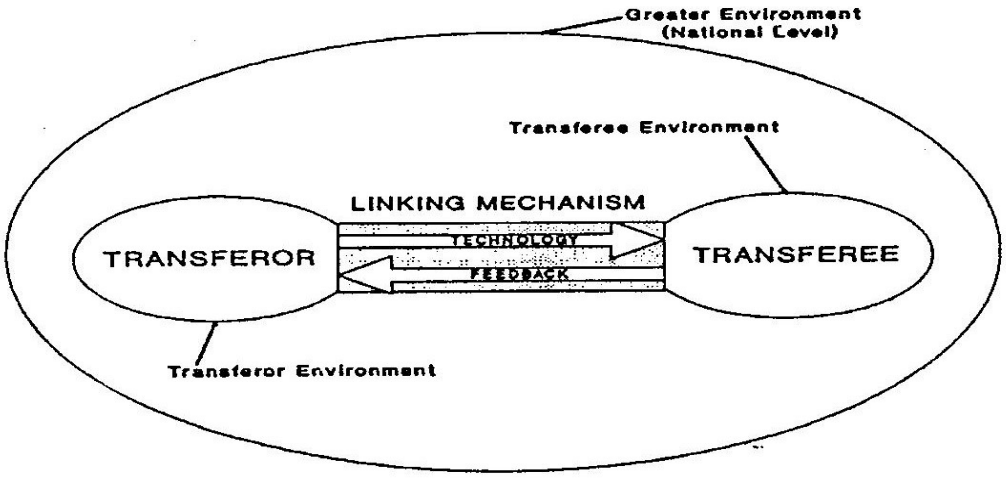

Fig. 3: Schematic diagram showing the technology transfer framework (adated: Schlie et al., 1987)

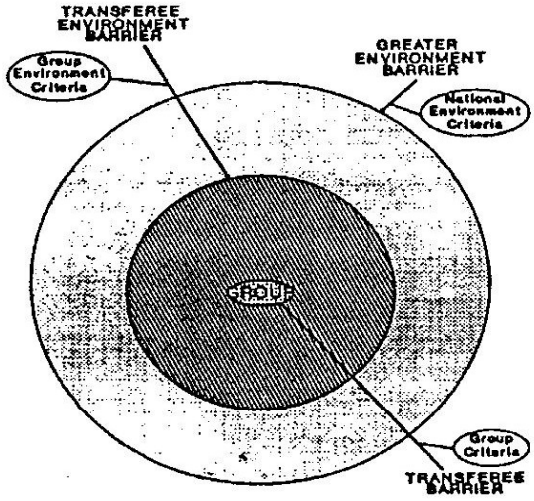

Fig. 4: Schematic diagram showing technological barriers and corresponding levels of criteria in technology choice at group level

The following sections examines each of the specific technology appropriateness criteria levels in a more detail. The criteria for assessing the technology climate will be dealt first and then followed by the criteria for assessing the group.

The Criteria for Assessing Technology Climate

There are two levels of criteria for assessing technology climate. These are the national environment criteria and the group environment criteria. The group environment consists of a series of environments extending from the village, ward, divisional, and up to the district level. The national environment consists of a series of environments which specifically deal with the provision of credit to the groups in the rural areas, in order for the groups to be able to finance the total cost of the technology

National environment criteria

The national environment criteria are largely economic factors related to technology. Affordability of the technology is the main issue at this level and it considers as a generic criterion the total cost to the group in the village of financing the technology. Credit management for group technology-based activities in the village and development of relevant policies, is an issue which the national financial institutions have to take into account while planning credit schemes. The total cost includes investment costs and operational costs. The investment costs include the cost of machinery, equipment, installation, buildings, interest on borrowed money, etc. The operational costs include costs related to labour, materials, maintenance, repair, transportation, the initial working capital (which could be in the form of cash or materials depending on the type of technology), etc. The possible criteria to be considered at this level are presented in Table 1.

The preferable total technology cost has to be less than what the national financing environment can afford. In other words, the loan acquired from the lending institutions plus the group's own finance should be more or at least equal to the total cost required by the technology

Table 1: Criteria to be considered for evaluation of the national environment

Generic Criteria	Criteria Description	Criteria
COST (Affordable)	In addition to the group owned finance, the access to loan and availability of credit at the time when is required. Usually evaluated by the amount of loan extended, interest rate, lending institution's agreement procedures, requirements of generating bankable documents, lending policies, financial and fiscal policies.	* Size of investment required

Group environment criteria

The supporting infrastructure and institutional services have been defined as consisting of extension services, repair and maintenance workshop facilities, and basic services and infrastructure. These have been classified in terms of generic criteria such as operations logistics, maintainability/ adaptability and basic services/infrastructure as shown in Fig. 2. The operations logistics, maintainability and adaptability have been defined as technical factors. The social factors includes criteria related to basic services and infrastructure. Therefore, the supporting infrastructure and institutional services are based on techno-social factors.

The possible criteria to be considered for the formulation of criteria for the supporting infrastructure and institutional services, are shown in Table 2. The development of the criteria in each generic criteria, have been drawn from the work of various analysts and have been accordingly classified as presented in Table 2. The relevance of the criteria depend on the kind of technology which is to be assessed. However, a preference of the group whether they would prefer more of, or less of, or the same as exhibited by the technology, has to be determined by the group itself. In addition, the group also has to determine the weightage for the criteria.

On the other hand, the experience from the sunflower oil processing projects in Tanzania, has shown that the supporting infrastructure and institutional services influenced to a great extent the supply of raw materials and market outlets required by the technology. A case in point was the institutional services such as extension staff, who provided the women's groups in the Iringa region with the knowledge of sunflower seeds availability and markets for the produced oil. Transportation of sunflower seeds from

neighbouring villages and oil for marketing, were also facilitated at times, in the Iringa Rural district. The extent of development levels of the basic infrastructure such as roads and market centers in the respective groups, also affected the supply of sunflower seeds and markets for the oil.

The ineffective supply of raw materials and market outlets accounted for the poor utilization of the technology in some groups, and thus, became a main developmental issue in the rural areas of Tanzania. Therefore, the use of raw materials and market as criteria for assessing the conduciveness of the group environment, could assist in examining the performance of the group with respect to effectively using the technology.

The Criteria for Assessing the Group

The group criteria as already pointed out covers technical, social, and economic aspects of the technology with respect to the group itself. The technical aspects consist of criteria that deal with operations logistics, maintainability and adaptability. The social aspects includes criteria that deal with socio-cultural issues. The economic aspects accommodates criteria that deal with benefit issues of technology. Therefore, the group criteria also contain techno-socio-economic factors. The assessment of technologies for rural areas would therefore be made in techno-socio-economic terms.

Disaggregating the technology into the four components, provides a detailed analysis of the criteria in a more systematic manner. Therefore, each of above generic criteria (operations logistics, socio-cultural, maintainability and benefit) has to be interpreted in terms of the four components, namely technoware, humanware, inforware and orgaware. In each generic criteria, a formulation of relevant criteria with respect to each component of technology, has to be made. Table 3 provides a general descriptive guide of possible criteria to be considered for each generic criteria. The respective criteria for each generic criteria in terms of four components of technology are presented in Table 4. The relevance of criteria depend on the kind of technology to be assessed. The preference scale direction and the weightage of the criteria, has to be determined also by the users of the technology In summary, Fig. 5 provides the appropriateness criteria levels for choosing a specific technology.

APPROPRIATENESS CRITERIA AS PROVIDED BY THE WOMEN'S GROUPS IN TANZANIA

A conceptual framework of appropriateness criteria for choosing a specific technology for rural development has been developed consisting of three levels of criteria, namely, the national environment criteria (cost), the group environment criteria (raw material and market), and group criteria (in terms of four components of technology).

A study was conducted in the six women's groups in December 1994 in Iringa region of Tanzania to examine the main factors which constitute the technology appropriateness criteria. The total population of the six groups using the Institute of Production Innovation (IPI) sunflower oil processing technology was 159 members. Two techniques of data collection, namely, socio-economic questionnaire survey and group interviewing techniques, were used. The socio-economic questionnaire survey was based on individual member interviewing, while group interviewing technique was based on interviews of group members. Out of 159 members there were 110 respondents for the socio-economic questionnaire survey In both techniques, the analysis as exhibited in Table 5, revealed three levels of appropriateness criteria for choosing a specific technology. The cost of financing the technology (affordability) was found to be the prominent factor in rejecting the technology. The second level of technology rejection included raw materials (seed supply) and market factors as shown inTable 5. The remaining evaluation factors were grouped to be at the third level. The Iringa women's groups therefore illustrates the existence of three levels of appropriateness criteria for choosing specific technology. These three levels of technology rejection are similar to that presented in the preceding chapter and summarized as Fig.5.

CONCLUSION

Appropriateness criteria is an important element in technology choice for rural development. Unfortunately, appropriateness criteria is derived from the term "appropriate technology" which means different things to different analysts. Therefore, the main aim of this paper was to provide an evolving approach of appropriateness that could place the whole issue of technological choice in perspective. This approach stresses that " the group (or a farmer) in the rural areas should choose technologies based on a

Table 2: Criteria to be considered to assess the state of suporting infrastructure and institutional services

Generic Criteria	Criteria Description	Criteria
OPERATIONS LOGISTICS (capabilities)	The extent to which the institutional services have the desired capabilities and qualities to handle the required operations of the technology such as provision of knowledge on production procedures, market outlets and raw materials availability as evaluated by the presence of the line agencies, the number of extension staff in the area, their pre-training (skills), experience and the prevailing educational program policy.	* Presence of line agencies * Number of extension staff * Skills and experience levels of extension staff * Frequency of visit by extension service * Educational program policy
MAINTAINABILITY AND ADAPTABILITY (of operations)	The extent of availability of spare parts and supporting workshops for maintaining and adapting the technoware as evident by the number of workshops, skills, experience, distance and the cost to reach the required item.	* Presence of repair, maintenance, adaptation workshop facilities * Type of fabrication materials endowed * Type of fabrication processes endowed * Skills and experience levels * Budget for follow-up to maintain operations
BASIC SERVICES AND INFRASTRUCTURE (orientation)	The availability and access to the basic infrastructure and services such as market centres, transportation system (roads), banking facilities, water supply, soil type, etc., which are necessary for technology and the extension staff to reach the client group as evaluated by the quantity and status of the infrastructure development in the area.	* Type and quantity of basic service and infrastructure * Status of basic services and infrastructure

Table 3: Criteria to be considered for the formulation of generic criteria in terms of four components of technology

	COMPONENTS OF TECHNOLOGY (CRITERIA DESCRIPTION)			
GENERIC CRITERIA	TECHNOWARE	HUMANWARE	INFORWARE	ORGAWARE
OPERATIONS LOGISTICS (capabilities)	Ability to handle variety of materials, energy, by-products (wastes), storage, etc.	Learnability potential in developing skills, experience and creativity for handling operations of technoware	The access to information and having the knowledge to operate the technoware	The type and style of leadership, the extent of involvement, and the management techniques used in directing the operations
MAINTAINABILITY AND ADAPTABILITY (of operations)	Ease of maintenance and adaptation in terms of replacement and precision required	The skills, experience and creativity needed to repair, maintain and adapt the technoware	Type of info & communication required for repair, maintenance & improvement of technoware	Extent of after sale services (follow-up), and the ease with which the technoware can be put back to operations when there are breakdowns
SOCIO-CULTURAL (orientation)	Ability to produce desired materials attributes such as appearance, flavour, purity, etc.	The willingness to adapt to customs, gender ownership patterns, religion, beliefs, classes, ethnicity, and gender activities	The type of information storage and methods of retrieval for the operations of technoware	Work environment as regards to gender participation, work organization, entrepreneurial spirit, and linkage with other institutions
BENEFIT (Adequate)	Ability to yield benefits desired by users in terms of time efficiency, etc.	Integrity of operations as evident from dividends and distribution of earnings	Level of awareness creation with respect to using technoware	Extent of profitability, internal rate of return (IRR), and service provided to the village population

Table 4: Possible Criteria in terms of four components of technology for assesment of the group situation

	COMPONENTS OF TECHNOLOGY (CRITERIA)			
GENERIC CRITERIA	TECHNOWARE	HUMANWARE	INFORWARE	ORGAWARE
OPERATIONS LOGISTICS (capabilities)	* Scope for utilization of raw materials varieties * Degree of energy saving * Operating space required * Degree of waste usage and pollution prevention	* Degree of use of available labour and skills * Ease of imparting operation skills * Extent of education levels	* Degree of use of information storage facilities	* Extent of leadership to direct operations * Extent of involvement in operations * Extent of use of management techniques
MAINTAINABILITY AND ADAPTABILITY (of operations)	* Type of lubricants * Degree of component precision * Reliability level (guarantee)	* Degree of use of available skills * Ease of imparting skills (repair, maintenance, improvements)	* Degree of use of communication modes for follow-up	* Extent of after sales service (follow-up) * Soonest the machines/equipment can be put back after breakdown
SOCIO-CULTURAL (orientation)	* Product appearance * Product taste	* Gender ownership pattern * Degree of non-adverse impact on customs, beliefs, religion, etc.,	* Degree of use of methods to retrieve information from storage facilities	* Extent of gender participation * Extent of work organization and suitability to the community
BENEFIT (Adequate)	* Level of productivity	* Extent of income generation for individual * Extent of distribution fairness	* Ease of awareness creation	* Degree of enhancement of profitability * Extent of internal rate of return (IRR) * Extent of services extended to the community

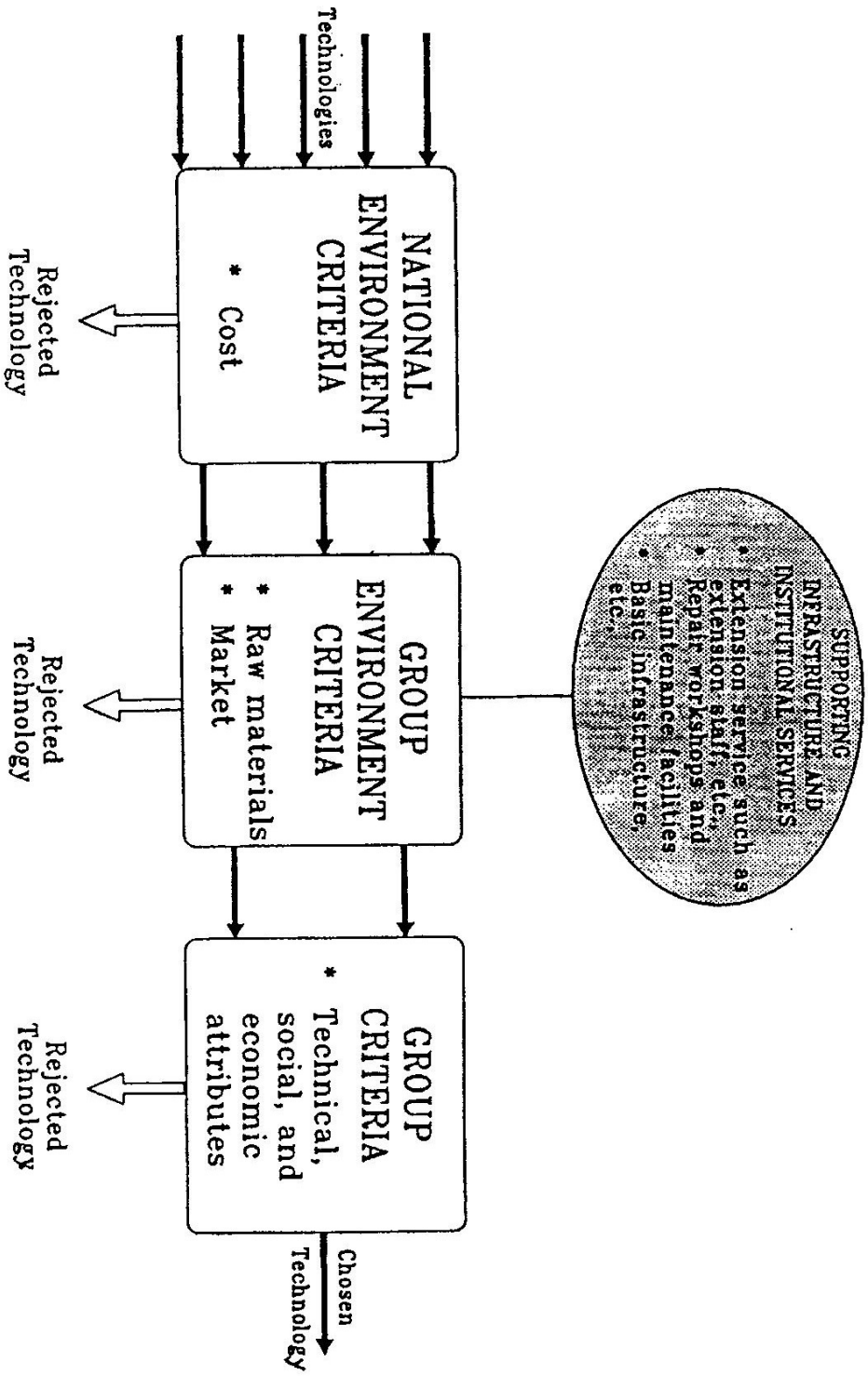

Fig. 5: Schematic diagram showing the levels of appropriateness criteria for specific technology

balanced set of relevant criteria that would reflect the concerns of the group (or farmer) as owner of the technology, the community which the farmer lives, the ruling party-the government, and non-government organizations, while ensuring that the probability of success and expected returns through the adoption of the chosen technology are enhanced". The approach however, has also been demonstrated by the six women's groups in Tanzania which showed similar pattern of the appropriateness criteria with the one developed conceptually.

Table 5: Women's groups responses on key levels of technology appropriateness criteria

Data Collection Technique	Evaluation Factors						Respondent
	Seed Supply	Market	Finance Costs	Leadership	Spare Parts	Extension Support	
GROUP INTERVIEW	18	18	24	7			25
Respondent*	72	72	96	28			100
Percentage							
SOCIO-ECONOMIC#	77	69	100	16	24	45	110
Respondent	70	63	91	15	22	41	100
Percentage							

* Number of total interviewers in the six groups (average 4 per women' s group)

\# Socio-economic questionnaire survey (individual interview)

The developed appropriateness criteria helps to assess technologies by starting to analyse the responsiveness of the technology climate and then the group itself. This systematic assessment helps to conserve resources and time in choosing inappropriate technologies. By using the proposed appropriateness criteria, inappropriate technologies would be rejected in the first place by the technology climate assessment, where the national environment would act first and thereafter, followed by the group environment. The rejection processes would take place as long as the technologies under consideration do not conform with the "techno-socio-economic" conditions prevailing in the technology climate of the group. With certain policy adjustment in the technology climate, the rejected technology could be considered for further assessment. Only those technologies which met the requirements of the climate prevailing in the group, would be eligible for the last assessment using the group criteria. Thus, the developed appropriateness criteria is useful in planning the implementation of the technology and also identifying policy areas for effective use of the technology.

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DYNAMIC MODELLING AND SIMULATION OF MULTIVESSEL BATCH DISTILLATION COLUMN

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ABSTRACT

Traditionally, the separation of multicomponent mixtures by using batch distillation column, is accomplished by collecting the product at the top one after the other and recycling the off-cuts. Hasebe et al (1995) and Skogestad et al (1995), proposed an alternative design of batch distillation column. In this paper, a dynamic model of this new design was developed and simulation experiments were performed. The results indicate that the multivessel batch distillation column is feasible to operate. By using control scheme proposed by Skogestad et al (1995) the final composition in the vessels at infinite time (steady state) does not depend on feed characteristics.

INTRODUCTION

The batch distillation process mostly is found in situation where feeds change from batch to batch and where distillation is required at irregular intervals. Also, when the production of purest products from a multicomponent mixture is required.

Multicomponent batch distillation is becoming increasingly important as a result of the expansion of fine and specialty chemicals as well as pharmaceutical products industries. These industries are characterized by small amounts of products with high added value and greater demand for flexibility and productivity. Environmental protection which needs the recovery of profitable and toxic materials and development of advanced techniques in process control are also, the reasons for increase in popularity of multicomponent batch distillation.

Therefore, the availability of a practicable technique for developing effective and reliable operation of multicomponent batch distillation is very important. There are a number of researches dealing with multicomponent