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Gestation Lags for Implementation of Sponsored Research Studies on Development in Developing Countries: Some Real Cases from India[1]

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***A*bstract:** The objectives of decentralized planning in a developing country like India are to ensure balanced regional development and effective implementation of the basic needs and the anti-poverty programs. For successful planning and implementation of various development projects, it is necessary to have both effective macro policies and efficient micro decision-making processes. However, we find that the implementation of the research results takes an unusually long period of time in the developing countries.

We have conducted about twenty-seven interdisciplinary Operational Research (OR) type of studies on various interrelated issues on development in India over a period of 35 years between1982-2017. This paper is based on our experiences on some of the implemented and partially implemented studies at the micro as well as macro levels. The paper discusses specific efforts of persuasion over a sufficient long period of gestation and draws several lessons learnt in the process. Finally, an agenda for further action is suggested.

Keywords: Implementation aspects; Development issues; Developing countries; OR models; Gestation period

JEL Classification: O13, Q01

1. Introduction

The problems of development are ill structured, complex, messy and have systemic inter-linkages. In the year 1982, we had set up an Institute for research for addressing the issue of bridging the gap and creating the necessary theories to the various inter-related issues on development, specifically for a developing country like India. The Centre for Applied Systems Analysis in Development (CASAD) was set up with the agenda for creating a body of literature based on sponsored research studies in development in India. The agenda for research can be seen from the associated flow chart in Figure 1.

Some of the important sponsored studies that were initiated by us were as follows:

1. Study of Small Horsepower Diesel Engine Industry in India
2. Strategy for Development of Backward Areas
3. Use of Fly Ash in Brick and Cement Manufacturing
4. Impact of Voluntary Agencies on Rural Development

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5. Technological Forecasting of Pulses and Oilseeds in India
6. Natural Resources Data Management Systems (NRDMS) (Under this project we had conducted more than twenty-two separate studies on various interrelated areas on Development such as Education, Health care, Irrigation, Road Network Planning, Water Management, Location of Facilities, Agricultural Production, Industrial Planning, Energy Planning and other spatial infrastructure using methodologies of OR, Decision Support Systems and Geographical Information Systems).

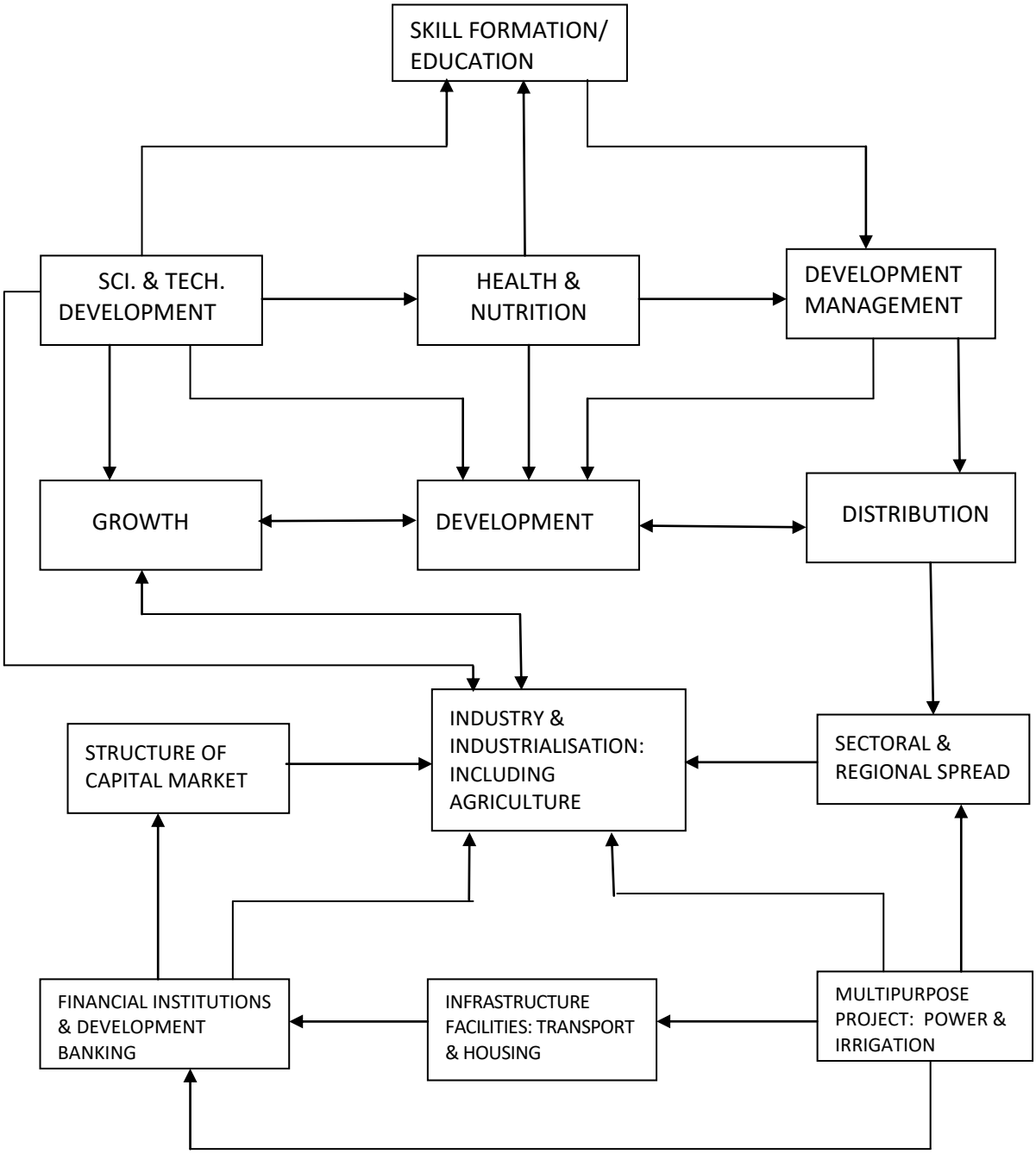

Figure 1. Interlinked Framework for Various Research Areas and Their Relationships to Development (Source: CASAD: An agenda for Research, CASAD, 1982)

This paper is based on our experiences on some of the implemented and partially implemented studies at the micro as well as macro levels. The paper discusses specific efforts of persuasion over a sufficient long period of gestation and draws several lessons learnt in the process. Finally, an agenda for further action is suggested.

It was observed that the gestation period was quite high in terms of implementation of the study results. Initially we thought that if we could persuade the decision makers over an extended period, the gestation period can be gradually decreased to an acceptable time frame. It was further observed that the complexity of the methodology used is not a function for implementation of the results. Sometimes a simple methodology was not implemented because it was too simple while a complex simulation model result was implemented immediately in a backward area, according to Bandyopadhyay and Datta (1990).

2. Sponsored Research Studies

2.1 Utilization of fly-ash

The study findings of the use of fly ash for bricks and cement which was published and disseminated in Chemical Engineering World in 1982 (Srivastava *et al*., 1982) was partially implemented till 1995 and was significantly boosted by the policy taken by Council for Scientific and Industrial Research (CSIR) post 1995. The physical and chemical analysis conforms that the fly ash can readily be used for manufacture of Portland-Pozzolana (PP) Cement and Bricks. It was found that up to 25% fly ash can be used in PP Cement and up to 40% fly ash can be mixed in clay for manufacturing bricks. This helped India in partially tackling the problem of soil erosion and solid waste management. A study of fly ash by Kumar, *et al* (2005) shows that the use of fly ash was 45 Million Tonnes/year in 2005 and is likely to go up to 270 Million Tonnes/year by 2017.

2.2 Strategy for development of backward areas

The study results for a Strategy for Backward Area Development was appreciated and recognized by all concerned, however, real implementation of the seven-stage algorithm was never attempted till now because of the longer period required for the implementation and the lack of motivation by the political system (Bandyopadhyay and Datta, 1989). The political system in India is believing in a five-year planning period and not very serious about a 15-16year planning period to tackle the complexity of developing backward areas.

It must also be seen that strategy should try to benefit the relatively poor in the rural agriculture sectors. A strategy of development benefiting the affluent and big farmers may further accentuate the economic disparities in the rural areas, creating more exploitation and rural unrest (Datta and Bandyopadhyay, 1994). Consideration of the above-mentioned aspects lead to the prescription of the following criteria:

- Efficient Resource Use
- Sustainability (Self-Reliance)
- Effectiveness
  - Harmonious Development
  - Inter-sectoral Equity
  - Inter-regional Parity
- Dynamic Adaptiveness.

The Seven Components of the Development Strategy were as follows:

- Increasing the Bio-mass and agricultural production
- Small scale energy and chemical production using bio-conversion processes
- Development of physical infrastructure
- Efficient production and local distribution of energy
- Dispersed Industrialization
- Exploitation of renewable sources of energy wherever possible
- Development of Health, Education and other facilities.

The entire planning process was divided into three phases which might take approximately 15-16 years. The three identified phases were:

Phase 1: Creation of an energy resource base

Phase 2: Infrastructure Development

Phase 3: Industrial Development and modernization.

The algorithm and the partial implementation aspects clearly indicates a likely implementable strategy for successfully achieving the goal in rural India. The study was initiated by Industrial Development Bank of India in 1982 and later, pursued through the various complementary studies conducted by the Department of Science and Technology, Ministry of Science and Technology, Government of India. The persuasion process was continued through the implementation of the models in selected states by the Natural Resource Data Management System Project of the Department of Science and Technology.

A paper was published based on the study in the Journal of Operational Research Society (Bandyopadhyay and Datta, 1989) and was awarded the prestigious Sir Charles Goodeve Gold Medal as it was found to be the most outstanding paper of the year. The Medal Committee observed the following:

"*This paper reports what is to be a sustained attack on a massive socio-economic problem. Partial implementation is already obtained, but it is for the clear formulation of what is needed, for the sound technical basis for analysis, and for mature planning, that the authors deserve recognition. The approach they adopt should be readily generalizable to other tasks with strong social and political impact.*"

2.3 Other NRDMS projects

The project NRDMS of Department of Science and Technology (DST) continued its activities in terms of creating spatial data infrastructure and development of models through specific research studies by various national level research organizations.

The existing approaches and many of the models do not display wisdom but concern themselves with short-term maximization of return only. There is a need to bring 'wisdom' in model formulation. The existing models seldom capture the nature of conflict inherent in devising strategies for agriculture and rural development. Some of the conflicts are:

- Extensive versus Intensive use of scarce resources (water, fertilizer, and pesticides).
- Maximization of the yields over a longer period as opposed to short period (long term sustainability).
- Consideration of distributional effects along with growth and resolving the conflict between growth and distribution (both sectoral and spatial).

Many critical aspects must be dealt with while formulating an effective OR Strategy. This may lead to sacrifice of productive efficiency at the macro level. Desirable degree of sacrifice of productive efficiency for obtaining better effects on distribution is a matter of policy choice. Next, the short-term maximization should not lead to problems in the long term. Thus, in irrigated areas maximization of production through high yielding variety, chemical fertilizers and pesticides might create problems of sustainability.

It was found that instead of having very high production for a limited period with concentrated optimal inputs, it may be better to have less than optimal production over a larger area with less use of scarce resources. Thus, the effect of production strategies on soil condition, use of non – renewable resources and ecology must be properly assessed. A simple straight forward maximization of yield may not be adequate. The model and problem formulation must also ensure that spatial distribution of growth must reduce existing disparities in development. Irrigated areas and relatively fertile land usually get attention in designing strategies for increasing agricultural production.

It was felt that no effort of development could be perfect without constant monitoring and feedback. Improvement and modification of strategies of rural development require scientific evaluation of the development strategy that has been implemented.

Many of the methodologies suggested by the Natural Resources Data Management System Project (though implementable) are partially implemented by only a few states (like Karnataka and West Bengal) after a lag of 20 years. The two state governments have committed to use the data base and the associated methodology for the development of the states since 2017.

2.4 Impact assessment of SKDRDP

A voluntary agency SKDRDP (Shri Kshetra Dhrmasthala Rural Development Project) with the help of funds from the international agencies undertook integrated rural development with special stress on development of poor and long-term sustainability in several villages in Karnataka State in India. It was felt that along with economic development, social development of the area and the infrastructure are necessary for making the development efforts successful.

Based on a selected sample of households a detailed impact study was conducted (CASAD, 1989). It was found that the strategies followed helped in developing progressively the productive potential of the households. There was long term sustainability. However, spatial effects were not totally without blame. In fact, the lesser the distance from the main center to the village determined the degree of beneficial effect. Thus, the remotest areas benefitted less. This evaluation therefore points towards the need for more careful incorporation of the needs of the remote areas while formulating the strategies. The income effect of the strategy was harmonious. Asset formation of the poor in the villages mainly took place in terms of plantation of trees and this asset formation was uniform across families.

Awareness of beneficiaries was better than that of the non-beneficiaries but still they were not aware of many modern methods of sanitation, nutrition and productive agriculture. It was found that

leadership of the project team had significant impact on the project success. This case study was devoted to overall rural development and the results pointed out to several lessons which may be useful in the future development efforts in the rural areas.

The following lessons were learned:

(i) Local participation in implementation of development projects is very useful.

(ii) Charismatic leadership creates conditions of non-duplicability.

(iii) Adequate pre-planning, proper extension efforts increase duplicability.

(iv) In project formulation the degree of resources availability and use and supervisory effort that can generally be applied to all project areas should be taken into consideration.

(v) Proper design of monitoring and information system should form an integral part of rural development.

(vi) A model integrating inter-sectoral programs is likely to be more successful.

(vii) The task of rural development and poverty eradication should take into consideration the issues of infrastructure, provision of material at the right time and creating appropriate maintenance facilities and marketing arrangements for final product. Only when all these are ensured one can then arrange for the required finance for the various activities of the project.

The results of the case study gave interesting insights in developing methodologies, for devising an acceptable development strategy. The study results were already implemented in 82 villages in Dharmasthala. However, there is a need for duplicability of such efforts in other areas of India, which is not forthcoming.

2.5 A Study on small horsepower diesel engines industry

The study on small horsepower diesel engine industry provided specific suggestions aimed at redressal of the following problems:

(1) To stimulate future demand

(2) Design Modifications

(3) Alternate Fuels

(4) Alternate uses

(5) Creation of R&D Infrastructure

(6) Organizational Requirements

(7) Research Efforts Necessary in the Future.

The research study was the first comprehensive systems study of the industry conducted by a team of interdisciplinary researchers (Bandyopadhyay and Datta, 1985). The study was sponsored by the Industrial Development Bank of India and was conducted with close coordination with the producers as well as the users. The research results showed that the fuel savings that can be realized with the modernization and various innovations was of the order of 1 million kilo liters of petroleum fuel with substantial savings of foreign exchange.

The implementation of the study largely depended on the pressing issue of savings in petroleum fuels and associated foreign exchange. The dissemination of the research results and the

understanding of the stake holders enhanced the degree of implementation within a reasonable time frame.

2.6 Block level energy planning

Subsequently, we had initiated a study on Block Level Energy Planning in Bankura District in West Bengal State in India. The energy demand was estimated based on different socio economic and environmental conditions. The demand was divided into four major components (Domestic, Agriculture, Industry and Transport). An allocation model was developed using linear programming for the optimum allocation of energy resources at the block level (Datta, 2012).

The objective function was divided into two parts: one for the locally available renewable resources and the other for the external resources. The interactive program allows the user to the resources available as well as demand to generate many feasible alternative resource use profiles. The exercise of generating alternatives help the decision makers to understand the worth of each unit of the resources and indirectly offers some flexibility in the decision-making process (Datta, 1994).

This was a good learning experiment, but the implementation was very partial and in the selected district only.

2.7 Healthcare planning and location of facilities

In view of the increasing population we must create new health facilities and locate them in appropriate places for maximal utilization of the resources. The basic attempt in this Decision Support System (DSS) was to develop descriptive models that are interactive and dynamic (Datta, 1993; Datta,1994). The decision makers can evaluate the effects of alternative strategies by using these models. The DSS module consisted of two sub modules: a) Facility Sub-module and b) Location Sub-module.

The main features of the Facility Sub-module are: a) How many new facilities of different types (Sub-centers, Primary Health Centers, Community Health Centers, and number of doctors and other paramedical staff) to be added in each year of the selected five-year plan. The choices available to the user are Growth path, Percentage achievement of the target in the year, nature of transition path (proportional, initial slow or fast path). The program also calculates the requirement of Family Planning Measures and Immunization Programs. Finally, the capital investment needed for the new facilities, additional manpower costs and the maintenance costs were calculated.

The Location Sub-module used a capacitated maximal covering location (CMCL) heuristic (Datta and Bandyopadhyay, 1993). The module has two choices. The user can select the optimization mode and select the number of potential locations or can select the interactive mode and according to the budget availability and other constraints may select any alternative location and see the effects of locating the center. Various alternatives can be generated and evaluated (in both tabular and graphics mode) before taking the location decision by the user (Bandyopadhyay and Datta, 1990).

The module was developed after prior discussion with the decision makers in two districts in India. Although the modules can be used for all districts in India it is being used by a few districts to find out the relationships of the interacting parameters of the system. The replicability in other districts may take some more time.

2.8 Technological forecasting in oilseeds

In the year 1984, the import of edible oils in India reached a very high amount of foreign exchange outflow (almost Rs.14000 Millions) and the Ministry of Science and Technology sponsored a study on Technological Forecasting in Oilseeds in India. The Technology Mission on oilseeds was also initiated during the same time. The case study considered the macro oilseeds production as well as the processing for edible oils. The strategy considered long term forecasting and ensuring sustainability. The strategy was expected not to create imbalance and disharmony in respect of other food crops or cash crops.

A separate demand model and a supply model were developed along with an integrated Demand and Supply matching model. Alternative scenarios were generated and methods of meeting the demand were demonstrated (CASAD, 1990). Distributional and Spatial effects were explicitly considered in the model. Similar models were also developed earlier for production planning and forecasting for Pulses (CASAD,1987).

The huge outflow of foreign exchange and the realization of the gravity of the problem was understood by the Government and the other stake holders. The reason was well articulated for considering the issue on a mission mode. The implementation was much faster than other development problems and the import of edible oils came down to a reasonable and acceptable amount within 4-5 years.

2.9 Micro watershed management system

The Micro Watershed Management System is an integrated Decision Support System (DSS) model developed for generating alternative water allocation and agricultural production scenarios for the sub-district level (Datta,1995). A Simulation model was used to generate feasible alternatives of water allocation and its impact on the value of agricultural; production in the selected agro-climatic region. The generation of such alternative resource allocations and potential production estimates will give an insight in terms of the true opportunity costs for the scarce water resource in a watershed and help rational decision making. With the help of such DSS models the user can generate many feasible alternatives in a very short time and use the saved time in resolving the complex issues on implementation.

The model results and the generation of descriptive statistics helped the implementation of the results. However, the implementation was restricted to the selected watersheds in the study region. It was assumed that the duplicability of the similar models in other watersheds will follow due to the realization of the benefits in terms of additional farm income. The publication and dissemination of the study results were restricted to reputed International Journals (in English) and a few National level seminars.

A much wider dissemination would have occurred if the findings were translated to local and regional languages and discussed in workshops at the District level in various states of India.

3. An Agenda for the Future

Various methodologies were used for sustainable development of developing countries in the past. All these methods have had very limited success. The problems of sustainability can be resolved through innovative methodologies for resource sharing and technology use. However, there are major constraints in developing countries like corruption, infrastructure inadequacies,

bureaucratic deficiencies, long gestation periods in implementation and mistrust of local people for outsider consultants (Datta,1990).

The problem environment and the criteria of problem solution is quite different in developing countries making the implementation process very difficult in reality. The degree of emphasis on a) (spatial, sectoral and temporal) distributional b) technological c) infrastructural and d) managerial including bureaucracy and corruption makes the OR studies on development more challenging (Bandyopadhyay and Datta,1990).

The critical aspects to be dealt with in the formulation stage are as follows:

a) An attempt should be made to maximize the spread of benefit from a given quantum of resources since certain resources are scarce. This may lead to sacrifice of productive efficiency at the macro level. The model may simply provide information regarding possible trade-off between levels of distribution and degree of productive efficiency.

b) The short-term maximization, generally, should not lead to problems in the long term. However, in irrigated areas, maximization of production through high yielding variety, chemical fertilizers and pesticides might have created problems of sustainability. Instead of having very high production for a limited period with concentrated optimal inputs, it may be better to have less than optimal production over a larger area with less use of scarce resources. A simple straightforward maximization of yield may not be adequate.

c) The model and problem formulation must also ensure that spatial distribution of growth must reduce existing disparities in development. Irrigated areas and relatively fertile land usually get attention in designing strategies for increasing agricultural production. Often the results were spectacular in the short term but eventually resulted in increased regional disparities.

d) Any model formulation must incorporate these criteria, in addition to the criteria of efficient resource use. It may be clear from this that the formulation of systemic models incorporating the above criteria is much more complex than the formulation of standard optimization models.

We are accepting the fact that all issues relevant to modeling of complexities in respect of development have not been resolved. However, a beginning has been made towards looking at these aspects seriously.

4. Concluding Remarks

A few case studies have been discussed here to find out the gestation period of implementation of the study results and is presented in the following Table. The gestation periods in the developing countries are on the higher side.

The experience of all these case studies show that although the reality was adequately captured, the degree of implementation was not according to our expectations. The factors responsible for the gestation lags were behavioral, socio-cultural, existence of value conflicts as well as technical.

Table 1. Selected research studies, approximate gestation periods, and specific efforts for implementation

Research Study	Gestation periods	Comments on Persuasion Methods
Utilization of Fly Ash	12 years	The implementation improved post 1995 because of Council of Scientific and Industrial Research (CSIR) involvement.
Strategy for Development of Backward Areas	30 years?	The implementation is at most partial. The need for OR type model solutions and the complexity was realized. The implementation is at a micro level and the macro implementation is hindered by the realistic time frame of the suggested strategy.
NRDMS Studies	15-16 years	From the District level now, we have two states (Karnataka and West Bengal) adopting the methodology. We do hope that other states will follow and implement the same methodology in future due to the National Spatial Data Infrastructure (NSDI) Project of the DST.
Impact assessment of SKDRDP	2-3 years	The project was a success at the local level. However, the duplicability of the model in other districts and States in India is not happening.
Diesel Engine Industry and Energy Planning	5 years	The problem was identified by the industry and all the stake holders were involved during the study period. This helped implementation in a reasonable time frame.
Energy Planning at the Block Level	10 years	The problem can be resolved through OR methodology. There is need for more efforts in terms of dissemination of the results. The data requirements can be captured through NSDI project of Govt. of India.
Healthcare and Location of Facilities	10-12 years	The implementation is restricted to a few states and requires wider dissemination using local languages.
Technological Forecasting in Oilseeds	4-5 years	The problem was realized by all concerned which helped its implementation. The outflow of a huge amount of foreign exchange and the mission mode helped early implementation.
Micro Watershed Management System	7-8 years	The implementation is at best partial in two watersheds. The benefits are realized. Duplicability requires more wider dissemination and a stronger political will.

In our view, the degree of implementation will further improve if we could satisfy the following four conditions:

a) The study team should be from within the country and should be interdisciplinary. (If the team is international the solution methodology should be internalized)
b) There should be sustained (over a longer time horizon) public relations and more interactions through seminars and workshops with the decision makers and the stake holders of the decisions.
c) There should be good communications and involvements throughout the study period and the entire implementation process.
d) The dissemination of research results must be translated into the local regional languages and the implications of the decisions discussed with all the stake holders.

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