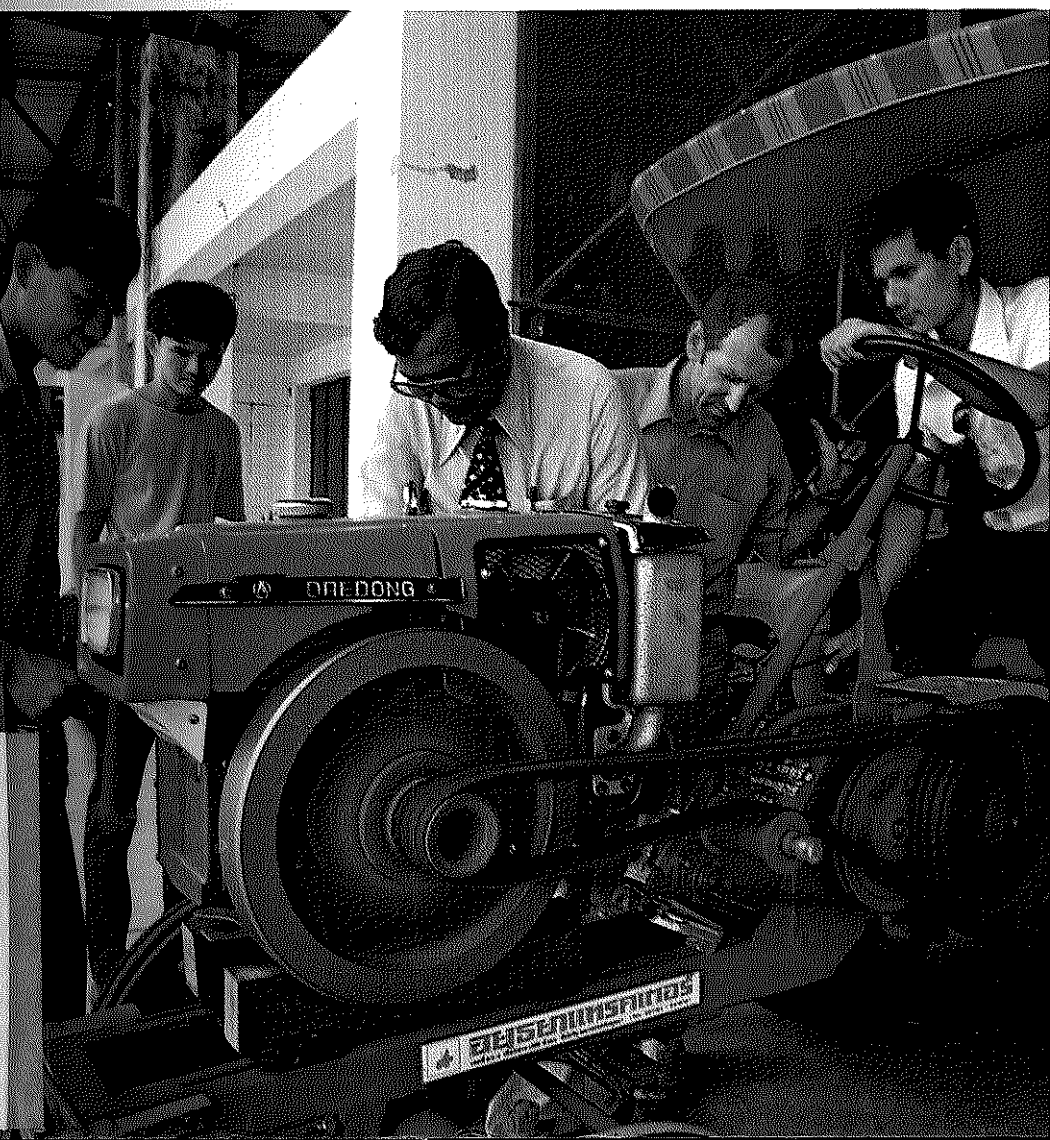
Agricultural Engineering Training and Advisory Centres as a Means of Promoting Agriculture in Developing Countries



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Foreword

The population explosion is forcing the developing countries to increase their production of foodstuffs and other agricultural products to an ever greater extent. Technical progress must, therefore, become part of the agricultural economies in the tropics and subtropics as it has done in the countries of the humid zones.

Technical progress in European and North American agriculture was shaped for many decades by the biological sciences and proceeded almost unnoticed. It is only since the end of World War II that mechanization has determined the extent and intensity of the agricultural revolution in the industrialized nations.

Many developing countries regard mechanization and "modernization" of their agriculture as the panacea which will improve and guarantee their food supply. This, however, ist not the case.

In the tropics and subtropics, too, the most important task will be to develop and expand patiently and persistently the potential of the major crops and livestock. Mechanization of agriculture plays only a supplementary role which differs in major aspects from that which it plays in the industrialized nations. Whereas one of the most important tasks of agricultural mechanization in the industrialized nations was and still ist that of replacing labour, the aim of using tractors, agricultural machinery and appliances in the developing countries is the creation of additional jobs, together with improvement of the balance of payments and development of rural areas. Formulation of a suitable mechanization concept which is balanced from both an economic and operational point of view is far more complicated and difficult in the developing countries than in industrialized nations.

The profile analysis of bilateral Technical Cooperation projects in four countries with varying economic and social structures was initiated by the Department of Agriculture, Forestry, Fisheries and Rural Development at the Federal Ministry for Economic Cooperation (BMZ). The analysis endeavours to provide answers to questions of decisive importance in agricultural mechanization:

- In what way can and should German agricultural assistance provide appropriate support for the process of agricultural mechanization in the developing countries?
- To what degree can the likelihood, speed and scope of success in agricultural engineering projects be brought into justifiable relation to one another?
- How can available resources be put to optimum use?

I should like to express my appreciation to the four authors of this profile analysis, Prof. Dr. Reisch, Prof. Dr. Schnuer, Dr. Züfle and Mr. Goedicke, M.A., for their work and their careful compilation of this extensive and complex study. I should also like to express my particular thanks to Mr. Ulrich, Oberregierungsrat, who

untertook technical supervision and coordination of the work at the Federal Ministry for Economic Cooperation (BMZ).

Dr. Werner Treitz
Ministerialrat
Head of the Department of Agriculture, Forestry, Fisheries and Rural Development at the Federal Ministry for Economic Cooperation (BMZ).

SUMMARY

1. This study is based on evalutation of the relevant specialist literature and four reports on individual countries drawn up by a team of experts on the basis of the examination of agricultural engineering training and extension projects in four developing countries in 1977. The overall project was initiated in the form of a profile analysis by the Federal Ministry for Economic Cooperation (BMZ) in Bonn with the aim of obtaining data for an optimum concept for development projects in the field of agricultural mechanization, and in particular an assessment of agricultural engineering training and extension projects as a means of promoting agriculture in developing countries.

2. To begin with (Section 2, p. 15), the study describes the importance of mechanization in agricultural development and the way in which it depends, according to its form and extent, on the level of development attained by the country in question. The mechanization process itself is shown as the necessary combination of four essential components:
   - development of suitable equipment,
   - manufacture and maintenance of this equipment,
   - proper use and operation and
   - creation of favourable conditions for use.

   The four above-mentioned factors, all of which have a direct effect, determine the speed at which the mechanization process can take place in a country; it is, however, determined to an equal degree by the general economic, social and political framework conditions, which can hinder or accelerate the process. The fact that mechanization can lead to social disadvantages means that particular responsibility is borne by the political decision-makers.

3. Section 3 (p. 27) contains a summary of the reports on the individual countries. Development projects which have been running for a number of years in Morocco, Sri Lanka, Thailand and Turkey were chosen for the purpose of examining typical situations in various countries. In these countries, the economic, social, agricultural and business structures, together with the situation as regards vocational training and advisory assistance in agriculture, were subjected to critical examination.

   These framework conditions were set against the concept and realization of the agricultural engineering training and advisory project in question and the achievements (determined). It thereby became clear that the approach, institutional basis and equipment of each project lead to considerable differences in the degree of success and that many projects produce extremely modest direct effects, particularly if the target in view is practical promotion of agriculture and the success of the project is to be measured in terms of criteria such as the increase in productivity and income. However, the analysis showed clearly that the more important achievement of training projects lies in the development of a suitable infrastructure ("institution building"). Important factors here are the degree to

which the training is jobrelated and the creation of an appropriate administrative basis for the projects so that there is adequate certainty that they will have an effect in practice.

Evaluation of a project's achievements in the sense of a cost-benefit analysis is problematic; it appears more practical to follow the cost minimization principle and to aim for specific training and advisory targets with minimum expenditure.

4. On the basis of the knowledge gained from the studies of the individual countries, which dealt with widely varying promotion concepts under no less varying political and economic conditions, a strategy for mechanization of agriculture in developing countries is outlined in Section 4 (p. 65). This strategy works on the basis that top priority should be given to drawing-up of a "national mechanization programme" in which the development of the four abovementioned components is analysed and their promotion and development programmed in accordance with conditions prevailing in the country. None of the countries had produced programmes of this type.

   As regards the development of the components the investigations of the individual countries dealt with the fields of training and advisory assistance. In this connection the study points out the rapid and broad effect of informal training programmes and their suitability within agricultural engineering promotion projects. Formal training programmes are no less important in themselves. However, their length and the fact that they are heavily influenced by state training guidelines mean that they are consigned principally to the country's own education and training system.

   In places where formal programmes have to be part of development projects because the country itself lacks resources, the training must be clearly jobrelated and there must be an adequate guarantee that anyone who completes it will subsequently obtain a job which corresponds to his training.

5. In Section 5 (p. 75) the general concepts of the project strategy are developed into recommendations for the structure of development projects in the field of agricultural engineering. They do not take the form of directions for action, but are given as a variety of aspects, consideration of which is urgently recommended. The great importance of training and advisory assistance as part of agricultural engineering development projects is mentioned first and foremost. Orientation in this direction must be contained in the project concept in an appropriately clear manner. Training abroad is viewed in a critical light, but supported in spite of high costs and possible "alienation effects" for senior personnel. Training of counterparts must in general be regarded as the central element of training and advisory projects, since they are intended as the future holders of positions of responsibility within the institution concerned.

   As regards the project approach, the sphere of influence must be clearly defined and, irrespective of the level, a powerful, influential sponsoring institution must

be found in each case. If their approach is at national level, agricultural engineering projects as a rule have little direct effect, but provide the opportunity of achieving a broad spread via two or three multiplication stages using relatively few resources. This can produce a considerable indirect promotion effect, but this occurs only after quite some time and depends essentially on the existence of an efficient training and advisory system into which the "innovations" can be integrated. Under the conditions in most developing countries a regional or even local approach is, therefore, clearly preferable, particularly if the project contains aspects of a pilot or test nature which can be spread to other areas.

The extent of the approach and the project resources are to be carefully examined; the decision as to whether agricultural mechanization in a particular region is to be promoted by means of an individual project (Minimum Package Approach) or a comprehensive development programme (Comprehensive Approach) depend essentially on the development conditions in the country. Agricultural engineering development centres have multi-faced terms of reference; they need a clear outline of the role and organization of the various operational areas within the context of the conditions prevailing in the country; particularly as regards their effects on agricultural practice which is the primary area of promotion.

In view of the fact that agricultural engineering training projects involve "human investments", which it is almost impossible to speed up, and since in a project of this type – apart from pure service projects – a number of years of experience and consolidation are required following setting-up or expansion of the project institution, a project duration of at least six and often up to eight years must as a rule be expected. In principle it appears wrong to accelerate development through excessive personnel and resource input from outside and to aim for a shorter project duration, because in this way proper continuation of the project is placed at increased risk, with no appreciable reduction in the length of the project. Decisive factors for the duration and organization of projects should be, to a great extent, the internal conditions and potential of the country. As a rule, this would mean that in relatively welldeveloped countries (threshold countries) projects can be shorter and involve greater participation by the countries themselves; particularly in the field of investment (supply of equipment and running costs), whereas in less-developed countries only an extremely small contribution can perhaps be expected from the developing country and a similar project will consequently require twice as much time.

1. INTRODUCTION

1.1 Target and task of the study

"The Agricultural Aid Department at the Federal Ministry for Economic Cooperation (BMZ) intends to obtain a policy-setting basis for further activities in the field of agricultural mechanization in the Third World countries by means of a comparative evaluation of agricultural engineering training projects implemented within the framework of Technical Cooperation in Thailand, Sri Lanka, Turkey and Morocco. For this purpose the study is to indicate the complex interdependencies between appropriate mechanization and specific framework conditions, specify possible forms of optimum agricultural mechanization and provide planning aids for effective promotion of same by means of agricultural engineering training and advisory centres. The findings are to be formulated in the shape of basic recommendations as far as generalization is possible. The study is also to investigate which models will, when new projects of this type are started, best meet the requirements of individual countries in the future, taking into consideration their varying agrarian structures.

On account of the wide variety of economic, business, ecological and social conditions in the individual countries, there has to date been no generally valid development strategy for mechanizing agriculture in developing countries. It is, therefore, necessary to investigate the agrarian structure in individual countries as regards the actual possibilities which can be accorded to agricultural engineering and improvement of this structure. Particular consideration must be given to the effects of agricultural engineering training and advisory services, together with the general influence of mechanization on agricultural production, the socioeconomic conditions in the rural areas and the maintaining of natural resources."

The team of experts was also requested to determine what value is placed upon the German agricultural engineering training centres in agricultural development in each of the countries and how their current programmes could be improved if necessary.

1.2 Execution of the study

By means of an experts' contract with the German Agency for Technical Cooperation, Ltd. (GTZ) the Federal Ministry for Economic Cooperation (BMZ) commissioned the following group to execute the study:

P.T. Goedicke, M.A.	Area of responsibility: Economics
Prof. Dr. Dr. h.c. E. Reisch	Area of responsibility: Farm management
Prof. Dr. G. Schnuer	Area of responsibility: Agricultural training
Dr. A. Züfle	Area of responsibility: Agricultural advisory services, also leader of the study group

For scheduling reasons the group of experts carried out its investigations in Thailand and Sri Lanka in March 1977, and in Turkey and Morocco in September/October 1977. In each case the results were compiled as individual reports on the countries.

1.3 Documentation and literature used

A detailed list of the documentation and publications used in the case of each individual country is appended to the report on that country.

In all countries visited it was possible to interview the competent persons within the responsible ministries and national institutions. The information provided by the representatives of international organizations and foreign representatives, together with persons in the relevant sectors of industry and commerce, were also extremely useful. The group of experts would like to thank all the individuals and agencies whose support made it possible to execute this study in a comparatively short time.

2. POSITION AND IMPORTANCE OF MECHANIZATION WITHIN THE FRAMEWORK OF AGRICULTURAL DEVELOPMENT

2.1 Agricultural engineering and mechanization: Definition and programme

"Agricultural engineering" refers to the area involving "engineering in agriculture". It is an extensive concept, covering areas ranging from the basic principles of agricultural engineering to agricultural machinery and its use in operation sequences and the selection of agricultural engineering appliances on the basis of technical, economic and social criteria, and also including agricultural building. This corresponds to the FAO definition of agricultural engineering as "a field of engineering in which physical and biological science are utilized to find and use better means for producing, handling, processing and storing food, fibre and fodder to improve rural life and living conditions".[1]

Seen as a whole, therefore, agricultural engineering comprises

- development (design),
- manufacture and supply (including maintenance) and
- introduction of the "technical aids" to agriculture plus
- examination of their usefulness and effects under particular physical, economic and social conditions.

All work in the field of agricultural engineering assists, in the long run, in mechanization of agriculture. This signifies a technical and economic development process. It covers all measures by means of which the results of the activities carried out by agricultural workers and enterprises are to be improved and the living conditions of the farming (rural) population and the welfare of the nation are to be aided through (increased) use of technical aids and non-human energy. Mechanization is, moreover, a technical and economic process with considerable social effects.

In the narrower sense of its meaning, the term "mechanization" refers in particular to mechanization of the work involved in agricultural production processes (in other words, farm mechanization). In the developing countries mechanization of the branches ob production concerned with crops are given priority. As a rule, mechanization of animal husbandry becomes important only at a fairly high level of technical and economic development, if we ignore simple measures such as fences, protective sheds, watering facilities, dips etc. In its broader sense, mechanization of agriculture also means mechanization of the rural areas and extension of the traffic routes; in short, creation of the preconditions for optimum use of technical equipment and facilities in agriculture.

1 FAO report no. 28, 1977, p. 47

Work on agricultural mechanization thus comprises the following areas:

- selection and development of a technology which is of optimum suitability under the prevailing natural and structural conditions (production alternatives),
- examination of the mechanization alternatives, particularly as regards their economic, social, structural and personal effects,
- creation of appropriate material (physical) conditions for use by means of land development, land consolidation, irrigation and drainage facilities,
- creation of appropriate personnel preconditions by means of training and advice in operation, maintenance and planning of use,
- provision of technical aids appropriate to the conditions, including operating equipment and energy sources,
- creation of an appropriate spare part and repair service with qualified personnel.

2.2 Position of mechanization in the agricultural development programme

Agricultural development measures vary depending on the level of development. Agricultural mechanization is usually given higher priority in the so-called threshold countries (i.e. countries in the take-off phase) than in the countries which have not yet reached this level of development or who are even among the least developed countries (LDC). In these cases mechanization must be handled particularly carefully for economic and social reasons.

As a rule, the following factors – with variations in degree – are common to the developing countries:

- low technical level in production with low productivity on the part of the land itself and the labour force and consequently low per-capita national product, particularly in rural areas,
- serious job shortage, combined with widespread poverty, few economic driving forces and much migration from rural areas and
- economic dependence of the numerous small farms on rural enterprises, lenders and other parties responsible for economic links with outside.

Under such conditions it is difficult to improve the conditions of life of the rural families, who, as a rule, represent the decisive target group for the activities of the state and other institutions.

In order to achieve both economic, social, cultural and structural development of rural areas and the economic aims of increasing the domestic food and raw material supply, substituting imports and widening export possibilities in order to improve the balance of trade, four areas, which must be regarded as complementary factors in every successful agricultural development process, must, in general, be dealt with:

- provision of appropriate resources for modernizing production (in the broadest sense) and living conditions,
- imparting adequate knowledge, skill and desire in order to facilitate modernization of production and living conditions,
- creation of the economic and political framework conditions which facilitate savings (earning profits) and which, viewed over the years, also make this appear practical and, if necessary,
- abolition of written and unwritten legal and social norms which stand in the way of full realization of original individual and/or collective development impulses.

Each of these four components is essential for true development – in other words development sustained at least in part by the efforts of the families in question. If the third of the above-mentioned conditions in particular is missing, no development programme is possible in the strict sense of the term. In this case a supply programme at the most can be implemented.

As a rule, the basic idea of agricultural development programmes is to increase production capacities by means of suitable measures (land development, irrigation etc.), to use these capacities more intensively and to increase yields. At the same time costs and losses are to be reduced and the products better utilized. In this way it ist possible to achieve on the one hand an overall increase in rural income, a reduction in rural unemployment and in the rural exodus and, on the other hand, improved economic performance and a better foreign trade balance.

Mechanization of agricultura occupies a position of great importance in the implementation of this form of development programme. It is an extremely powerful means of improving traditional production and living conditions. As a result of the greater efficiency of technical energy sources (engines) as compared with human muscle power and animals, mechanical processes make ist possible to perform production work not only with less effort and physical stress, but at the same time also faster, better, in a more modern manner and thus with increased success. The more it is possible to improve the production result through effective use of technical aids and equipment, the greater the marginal benefit and the greater the importance of mechanization within agricultural development.

In detail, the following intensifying production factors play a part here:

- the genetic yield potential of the crops,
- the natural production conditions, since these determine the yield limits of the cultivation and the opportunities for using technical aids,
- the economic conditions, since the profitability of the production influences the degree to which the branches of production in question are worthy of mechanization (price-cost ratio),

- the structural conditions, since these determine on the one hand the opportunities for using technical equipment and on the other hand, through the distribution of the land, the extent of the individual benefit derived from mechanization and
- the overall economic situation, in particular the employment situation, since the utilization costs of labour and capital depend on this.

As regards structural conditions a distinction may be made between thinly-populated and densely-populated agricultural regions. These represent two basic types of agricultural areas involving greatly differing functions of mechanization (cf. also section 2.3).
In the thinly-populated areas, i.e. in areas with large reserves of land or a low ratio of population to agricultural area, we are concerned above all with horizontal intensification or, in other words:

- increasing production by enlarging this area (land reclamation),
- mechanizing land development to guarantee rapid expansion of this area and
- mechanizing large farms.

Under these conditions, the area and quantity of production grow as the contribution of the technical equipment increases. There is almost no substitution of labour; in many cases the labour requirements increase in the region as a whole.

In the densely-populated areas, on the other hand, the concern is with vertical intensification or, in other words:

- increasing production by intensifying cultivation
- mechanizing land development only as far as necessary (time factor)
- mechanizing the labour bottlenecks which occur in production on small farms.

Under these conditions only partial mechanization is possible in order to overcome the bottlenecks which occur in the production programme depending on the times at which the work is performed and the quality of the work and to derive optimum benefit from the small available production areas. Cultivation and post-harvest work must therefore always be considered in close connection.

Most developing countries can be classified as a whole or region by region in one or the other of these categories. In general, mechanization can be extremely useful and a high priority in both situations, but there are fundamental differences in the position, nature and extent of mechanization in the two types of area.

In thinly-populated areas, technical progress usually has only a slight social effect. In this case, agricultural mechanization can be pushed unhesitatingly to the ecological limits of cultivation if the economic and technical conditions so permit.

Agricultural mechanization in densely-populated areas is faced with different conditions:
In this case, it is easy for negative social side-effects to occur, for although the private economic benefit can be increased if farmers change over to cheaper technical solutions and cultivate themselves areas which they had previously let out, this can simultaneously lead to social and political problems with high subsequent costs (in regions with no alternative job opportunities) as a result of the manpower which ist then released. The use of imported machinery in this mechanization process can also produce a negative effect, because valuable jobs are shifted abroad and scarce foreign exchange used. In such situations desire for personal gain must, if necessary, be checked and controlled for reasons of social policy.

Yet, another aspect is of importance in this context: all the above-mentioned tasks of mechanization represent investments, some of which place high demands on capital and time, such as:

- investment in a thorough analysis of the country's situation and the development possibilities from the point of view of technical progress as an aid in agricultural development,
- investment in institutions for machinery testing, development and adaptation,
- investment in training and advisory personnel (human investments),
- investment in local or national production facilities and/or use of foreign exchange for imports,
- investment in land development measures and the rural infrastructure,
- investment in service facilities (material and human),
- investment in credit facilities and provision of funds for same.

Each of these forms of investment involves a decisionmaking and realization element. It is of paramount importance for the mechanization process who (what institutions, persons etc.) is responsible for decision-making and realization at the various levels and whether there is clear and logical allocation of responsibilities.

Basically, it is possible to distinguish two groups of countries; on the one hand those with a free market economy and on the other those with a planned economy.

The policy of the countries with a free market economy is principally that the state should endeavour to influence the economic processes by means of marketaffecting measures (land development, production incentives, quotas, pricing policy etc.), but that it otherwise largely refrains from engaging in independant production and market activites.

In countries with a planned economy (some of them Socialist), the state intervenes directly through its institutions and performs a wide variety of functions. In extreme cases it may take over completely the control and development of the sector in question through the introduction of its own activities (state farms, state organizations).

As regards agricultural mechanization, initiatives and progress in the first-mentioned group of countries will result predominantly from the profit motives of individual persons and farms; they must then be set against the other conditions in the country (requirements and limitations).

In the second group of countries it is assumed that in general – or possibly for special regions or types of farms, such as smallholdings – crucial impulses must come from the state. This is undoubtedly correct in the case of the least developed, poorest countries and regions.

State influence takes a wide variety of forms and operates at various levels and in various sectors. However, a feature common to both groups of countries appears to be that the bodies responsible for decision-making and realization are in most cases widely split up – according to departments, branches of production, spheres of responsibility and other criteria. This makes coordinated, puposeful development promotion extremely difficult in most cases and, under certain circumstances, almost impossible. There is yet another important basic fact involved in the promotion of agricultural development. Mechanization – just like every other form of technological progress – is more inclined to benefit those who become aware of it earlier, apply it sooner and can use it to greater profit. In principle this creates the risk that the social gap will be widened if specific steps are not taken to prevent this. However, progress is inhibited if the substantially individual development force, which it has so far been almost impossible to replace successfully anywhere by some other "instrument", is taken away. Even in extremely poor regions with a low average income, experience has shown that it is possible to initiate an independent development process; even under such conditions there are always individuals and families who have more knowledge and experience and who ar usually also somewhat better-off and thus fulfil the minimum requirements for a development process.

As a whole, therefore, mechanization represents a field of agricultural development which is important but which ist also a somewhat precarious area. Private economic advantages are important development impulses on the way to increasing production and incomes. However, where the advantages become concentrated on a relatively small group, favoured by the development conditions, suitable measures must be implemented in order to guarantee or at least aim for, widespread participation in the development of the agricultural sector. In many cases this will be impossible without intervention in the existing agrarian structure (in other words, agricultural reform), particularly where a large number of families owning no land, or only very little, exist side by side with a small number of large farms. Mechanization in this case will otherwise increase the social differences still further.

In terms of economic and development policy, agricultural engineering may be considered consequently to have found its correct place if it does not serve so much to increase individual gain (possibly at the expense of others) and its aim is regarded benefit for all parties involved in one region or one country. Although agricultural mechanization takes place predominantly on the individual farms, the above remarks show that as far as development policy activities are concerned, appropriate consideration must always be given to regional and nation conditions when selecting an approach.

2.3 Operational and economic aims of mechanization

The primary effects of mechanization occur in agricultural production, but, depending on the nature and extent of these, secondary effects are also created, on one hand in the preceding and subsequent sectors constituted by procurement of operating equipment and product utilization and, on the other hand, at an economic level in the supply, goods and services and foreign exchange balances.

From an operational point of view, agricultural mechanization has the following aims:

(1) Increase of production capacity over a specified area (vertical intensification)

- by means of more precise, better-timed and lowerloss performance of work (ploughing, sowing, fertilizing, irrigation, pest and weed control, harvesting, transportation, storage, processing, animal care); modern means of performing highquality work are in many cases preconditions for successful introduction of other forms of technical progress (intensification factors)
- by means of intensifying the production programme, since the labour and time requirements of higheryield crops can be met with the aid of effective mechanization.

(2) Increase in production capacity by enlarging the cultivation areas (horizontal intensification)

- by adding additional land if land reserves are available or
- by increasing the cropping index for a given agricultural area.

In both cases it is particularly important that seasonal job processes or bottlenecks should be dealt with at the right time. Even in places where there is a considerable labour surplus throughout the year and the labour force is thus available with no utilization costs, mechanization can be practical from an operational and economic point of view if it serves to increase the average per capita contribution to the national income.

(3) Reducing labour costs

If we work on the basis of a definite production programme, reduction of labour costs plays the decisive role in the private sector. Under certain circumstances mechanization can be cheaper than manual labour even at relatively low wage levels (e.g. 1 US $ per day); from the privateenterprise point of view the profitability of replacing human labour by machines increases the more expensive human labour is or the cheaper the procurement and introduction of machinery. In considerations

of this type "invisible labour costs", such as strikes, unreliablility and inaccuracy, often also play an important part.

If the state reduces mechanization costs by means of its measures, it expands and accelerates the mechanization process, just as it can also inhibit it by means of contrary measures, since the operational decisions on the degree of mechanization take into account the following economic relations:

1. The marginal benefit derived from mechanization must in principle be greater than the marginal costs of the mechanization measures.

2. In the event of a changeover to a process at a higher level of mechanization and with fewer labour requirements, the cost of the new method must be lower than that of the one used hitherto. It should be noted that
   - the cost is to be assessed as nil in all situations where there is an adequate permanent labour force (family members) for whom there is no other employment and
   - yield and quality improvements, together with loss reductions as a result of the more highlymechanized process are to be deducted from these costs and reverse effects added to them.

3. In the intensification and expansion of the production programme the marginal benefit derived from greater mechanization is composed of
   - increased output due to better performance of work
   - increased output due to cultivation of higheryield crops
   - increased output through an increase in the cropping index and possibly also the irrigation efficiency
   - other advantages of mechanization (e.g. making work easier, no need for night work etc.) minus the additional costs of mechanization.

The most favourable relation between marginal benefit and marginal costs is, as a rule, achieved when it is possible to gear mechanization selectively to coping with peak work loads and bottlenecks. The periods of tilling the soil and field work, together with the harvest and subsequent treatment of the products, have caused particular problems in this way in agriculture. These are consequently the areas enjoying highest priority and the most widespread use of tractors and machinery. In addition, water is conveyed using pumps in many irrigated areas. A special position is occupied by weed control, which places heavy demands on labour, particularly in the case of irrigated crops. Weed control could be mechanized using relatively simple technical aids (drawn hoes, hoeing ploughs etc.), but herbicides represent an alternative method, which in many places is easier to introduce than the changeover to mechanical weed control. The decisive factor here is the cost of the chemical agents, which may vary greatly.

Irrigated farming, in particular, provides favourable economic conditions for mechanization. As a result of the high production intensity, the threshold for a practical transition from simple hand implements to higher degrees of mechanization is usually, in the case of private farms, only a few hectares of farmland per family (about 3 hectares). This applies even in places where no marginal labour costs are incurred for much of the year. The threshold is still lower wherever there is an opportunity to use a tractor for transportation or other paid work not connected with the farm.

Different economic conditions are to be found in the case of rain-farming, where the farms are as a rule too small to be able to introduce mechanization on their own. It is, therefore, particularly important that the small farms should be given the opportunity of using machinery by the hour to the required extent on a low-cost and reliable basis, without having to make investments and thus incur high fixed costs.

As regards economic influences, it may be clearly seen from the above that the operational decision-making situation can be altered greatly and in a wide variety of ways by state inervention. If the state offers consumer loans at favourable rates, low import prices, low-cost machine services and the like, it is not necessary for wages to be high or a considerable output increase to be attained for the transition to a higher level of mechanization to be achieved. Conversely, import restrictions on machines and a shortage of technical aids may lead to blackmarket prices or at least to high prices for services and thus to less favourable conditions for a higher degree of mechanization. The government can also control the mechanization process by exercising varying degrees of influence over the prices of major agricultural products and can pursue its objectives by utilizing the reactions of private farmers if it does not wish to intervene directly in production.

In general, the following may be regarded as economic aims of agricultural mechanization:

- increased output to ensure better food and raw material supplies for industry and the population in general, usually with agricultural land in short supply in relation to the growing population,
- increased exports to obtain essential foreign exchange,
- employment of a larger labour force and
- development of regional economic strength through land develompent and production increases.

Ideally, the labour released by mechanization in the primary agricultural production sector would be "absorbed" by the secondary effects of economic development and additional jobs even created. Balanced agricultural development of this type is difficult to achieve. As a rule, development in the primary sector races ahead, sometimes with considerable positive effects on production but without the necessary increase in the number of jobs. In such situations it is often the task of the state

to cushion the unfavourable regional employment effects, whereby it must find a compromise with minimum reduction of economic growth and guaranteeing of the humanitarian interests of all disadvantaged parties. Much depends on which development instruments a government uses and what plan it follows. The most unfavourable programmes are undoubtelly those in which on the one hand individual initiative is curbed and on the other the state is incapable of using effective resources of its own.

2.4 Position of training and advisory assistance in agricultural engineering within the agricultural development process

If we take training as meaning the imparting of "stores" of knowledge, which can be applied in the course of specific activities, and advisory assistance as being problem-related aid to make it easier to deal with particular situations or tasks, we may state, without reservation, that both are required in a wide variety of ways in the course of the mechanization process. The lower the level of training, the more important the extension assistance, which in extreme cases may even become the giving of instructions. The long-term aim, however, should always be a rise in the level of training. This accords training a position of fundamental importance, which also applies to agricultural engineering. Advisory assistance will always play only a secondary role.

Two basic forms of agricultural engineering training may be distinguished, varying according to their institutional aspects:

- training within the formal education system and
- training outside this system, referred to in short as informal training.

A distinction must be made according to subject matter between

- training dealing with mechanical aspects and
- training dealing with technical aspects of agriculture.

The specialized formal training system is concerned in principle only with young people of varying ages, depending on the level of training in question, which may be that at a vocational school, technical college, engineering college or university.

Each of the above-mentioned levels should provide the basic professional qualification for a specific area of activity.

In the mechanical field training is given at a variety of levels, from that of workshop mechanics through workshop foremen and production engineers to the agricultural engineers who will engage in research and teaching in the secondary and tertiary education sectors.

The area dealing with technical aspects of agriculture should contain the training programmes for farmers, tractor drivers, machine operators, agricultural engineering field advisors, agricultural engineers who will provide training and organizational aid in the use of machinery and the planning and administrative specialists in agricultural engineering.

Informal training, on the other hand, provides training and upgrading for the above-mentioned groups of persons, if they are already engaged in their profession, and does so in both fields of training discussed above.

Extension assistance serves as an important means not just of stimulating agriculture and influencing the human factor. It can achieve its maximum effect if appropriate resources are available and up-to-date knowledge on extension methods is taken into account. By means of a mass approach it is possible to reach both those who are interested or somewhat less interested, but in particular groups which cannot be reached by means of training programmes. On the other hand, extension assistance to groups or individuals is profitable wherever it is necessary to go into an individual problem in depth. It is precisely in fields undergoing rapid technical changes, such as agricultural engineering, that promotion activities of this type have particular merit. The boundaries between these and informal training progammes are thus fluid, since close interlinking of extension services and training exists, or is necessary, depending on the initial situation in individual countries.

3. ANALYSIS OF AGRICULTURAL ENGINEERING TRAINING AND EXTENSION CENTRES

An analysis of agricultural engineering training and extension centres can be carried out in a consistent manner only if it takes into account the factors resulting from the country's specific framework conditions.

Against this background the features of the agricultural engineering centres investigated in Thailand, Sri Lanka, Morocco and Turkey must be considered from the angle of their objectives, institutional foundations, equipment, use of funds, counterpart provision and actual training and advisory measures, in order to make it possible to draw evaluatory and comparative conclusions.

3.1 National conditions as a framework for the development of agricultural engineering

The findings made by the group of experts on the countries under investigation in the working reports entitled "Profile Analyses: Agricultural Engineering" (cf. section 1.2) are reproduced here in the form of a synopsis. The economic situation – both in general and as regards agriculture –, the operational situation for the farms and the position as regards training and extension services will be interpreted in such a way that the importance of these framework conditions for the approach adopted in development strategy is clearly recognizable.

3.1.1 General and agriculture-specific economic situation

The general outline of economic development projects is defined by the development plans of the countries in question. However, a country's level of development is also reflected in these plans and acts as a basis for further targets and measures. In the case of the four countries included in the profile analysis the development situation is as described below (cf. Table 1, p. 28).

As may be seen from the figures, an extremely high proportion of the working population in all four of the developing countries in question is engaged in agriculture and, apart from Sri Lanka, all the countries have a very high rate of population growth. On the other hand, the proportion of the Gross National Product accounted for by agriculture is comparatively modest. It is easy to deduce from this that agriculture in all four countries is at a low level of development and involves on the whole a large working population with a low level of income. Agricultural development is thus an important target, but it must be noted that the high unemployment figures, which probably do not even reflect the full extent of the situation, must be increased still further through the introduction of labour-replacing technologies.

The overall and agriculture-specific economic situation is as follows in the countries investigated:

Table 1:

Selected economic data for Thailand, Sri Lanka, Morocco and Turkey

– Extract from the working reports "Overall Economic Situation" –

Figures in %

	THAILAND	SRI LANKA	MOROCCO	TURKEY
Annual growth rate of the GNP – Period –	6,2 - 1971/76 -	3,6 - 1975 -	10 - 1976 -	7,2 - 1976 -
Annual growth rate of agricultural production*) – Period –	4 - 5 years -	2,1 - 3 years -	3,6 - 10 years -	3,7 - 5 years -
Share of individual sectors in the GNP (1975 and 1976)				
Agriculture	26	32	24	24
Industry	29	20	33	23
Services	45	48	43	53
Population growth	2,6	1,9	2,6	2,5
Unemployment rate	5	18	16	13
Agricultural labour force as a proportion of the working population	75	50	50	65

*) According to the Agricultural Commodity Projections 1970-80, Vol. I, FAO Rome, 1971, the annual growth rate of agricultural production for the world as a whole is 2.78%.

Thailand

Since 1950 the country's open-minded and liberal economic policy has contributed towards positive development of the economy.

One of Thailand's major problems is the high population growth rate, which exceeded 3% in the 1960s and is at present given as 2.6%. Visible unemployment is no longer a serious problem in Thailand, but there is quite considerable structural underemployment in both most rural areas and the commerce and services sector. In particular, there is high seasonal underemployment in agriculture; in many places up to 50% of the potential labour force remains unused on small farms.

In recent years Thailand has promoted in particular the agroindustries which process the country's own raw materials. Nevertheless, the country continues to be dependent upon imports in the food sector, since production is geared in an extremely on-sided manner to only a few products.

Agricultural production is based predominantly on the single crop of rice. It appears that in the future, increased production, which was mainly achieved in the past by increasing the agricultural area and which must be considered essential on account of the growing population, will depend largely on an increase in productivity, since suitable agricultural areas are in short supply and serious damage due to erosion must be feared.

For want of state intervention in agricultural mechanization, it was left to – and remains the task of – the private sector to determine the form of mechanization and to advance the process. The agencies of the various foreign tractor manufacturers acted as major "driving forces"; however, they are purely sales and financing organizations and provide almost no other services. Recently, a large number of small local producers have been manufacturing simple two– and four-wheeled tractors, using mainly foreign drive units (e.g. Japanese engines), together with simple ploughs, appliances and carts. These firms form the first hopeful starting point for developing the country's own agricultural machinery industry.

Numerous small repair workshops are scattered throughout the country. There are certainly enough of them, but they still lack specialized knowledge and technical equipment.

A result of the country's liberal mechanization policy is that around 90% of the tractor operating hours are accounted for by vehicles supplied by machine contractors. Over half of the contractors own land themselves. These contractors are farmers who were able to afford tractors and then wished to cultivate still more land. In many cases they took back land which they had previously let out, in order to cultivate it themselves, which led to an increase in the number of landless farming families. Other machines which are rented out are owned by merchants and dealers who have been able to increase their influence still further by means of the machine services.

Sri Lanka

The country's economic system, which up to the time of investigations could be described as subject to state control, suffers mainly from the problems of structural dependence on the three main exports – tea, rubber and coconuts – and a socialist distribution mechanism with the nature of a welfare state, which is contrasted by inadequate economic growth.

As a result of the precarious foreign exchange situation it has not been possible to build up an effective agricultural infrastructure. There is still a lack of equipment which would facilitate full cultivation on the agricultural areas. The State Trade (Tractor) Cooperation is the sole importer of tractors and distributes them via the district dealers to the farmers designated by the Ministry of Agriculture. Between 1971 and 1975 almost no fourwheeled tractors were imported and those acquired during the last two years came from a wide variety of different manufacturers. There is almost no production of agricultural machinery in Sri Lanka itself. The scarcity of foreign exchange thus exercises its full effect. In addition to the state distribution mechanism it is predominantly responsible for the fact that not enough tractors are available and that the few which are available are of too many different types, which causes additional problems in maintenance. Besides these difficulties, long periods elapse between the ordering and actual delivery of necessary spare parts as a result of the planning mechanism and regulation of foreign exchange. As a result of this, many of the tractors – which are relatively old as it is – are not in full operating condition.

Under these conditions, private dealers and workshops have largely lost confidence in the state procurement system. Cooperatives which also act as tractor dealers and workshops do not display the necessary care in using the machines, since they are not the property of individuals and the necessary supervision is also inadequate.

Morocco

Morocco is among the Third World countries whose development is determined to a great extent by raw material exports. Phosphate is by far the most important export.

In the country's development plans to date, agriculture and tourism have been the sectors of the economy given priority for promotion measures. According to the latest development programme, development of the industrial sector is to be of increased importance in future.

A distinction is made in agriculture between a "modern" and a "traditional" sector. Since the country achieved independence the modern sector has been the preferred target for promotion and development, which involved the creation and expansion of the large irrigated areas. In the mechanization of Moroccan agriculture, the contribution of the state consequently lay primarily in the provision of equipment for the capital-intensive irrigation projects. The large increase in the sale of tractors since 1965 benefited mainly irrigated agriculture; approximately two-thirds of all tractors are used in the irrigated areas.

Great reserve and relatively slow mechanization are in evidence in rain-farming in order to prevent excessive release of labour. Here too, machine stations have been set up, but with less equipment and less effect.

The country's policy on the organization of the provision or machinery has changed in recent years; the state machine stations have been gradually dismantled and cooperative acquisition and use of machinery stimulated by means of loans and grants. This process is laborious; financially well-off individuals, mostly farmers cultivating not only their own land, and also contractors of considerable size today provide an increasing proportion of machine services. Over 50% of tractors are at present being bought by such contractors.

Efforts in the field of tractor and machinery acquisition are aiming at reducing the obstacles to imports, assembling the machinery in Morocco as far as possible and developing the country's own production facilities for agricultural appliances. Good progress has already been made but the spare parts and maintenance system still contains serious shortcomings. The country is large and sales quantities small. The import firms can afford to maintain depots only at central points; still more serious, however, is the lack of trained personnel.

Turkey

Although it maintains that it has a free-market economy, Turkey shows signs of tending toward a mixed economy. Since the beginning of the 1960s the industrial sector has grown considerably and in 1977. for the first time ever, probably accounted for a greater share of the Gross National Product than the agricultural sector.

The state sector is being increasingly confronted with financial and administrative problems. The country is teetering on the brink of bankruptcy. The main source of foreign exchange is constituted by agricultural exports which are shrinking more and more as a result of the rapid population growth, while imports of consumer goods are increasing. There is a high degree of invisible rural unemployment and underemployment. An increase in production and the prevention of social mismanagement are the two central elements of the mechanization of Turkish agriculture.

Turkey is also without a state programme for agricultural mechanization.

Use of agricultural machinery, particularly imported tractors, is increasing in Turkey at a rapid pace and there are extensive plans to manufacture the machinery and appliances within the country. Today approximately 600 Turkish firms of every possible size manufacture agricultural machinery and appliances which, however, are for the most part more or less successful copies (as regards quality and operation) of foreign models. Only some of them are makes manufactured under licence.

Original developments and designs are still of secondary importance in the manufacture of agricultural machinery in Turkey.

Particularly important among the manufacturers of agricultural machinery is the state firm of TZDK (Türkie Ziraie Donatim Kurumu). It takes the form of a directorate-general under the Ministry of Agriculture and is intended in particular to assume the leading role in the construction of tractors and vehicles with the relevant machinery and appliances and to supply, in some cases, up to 50% of domestic production.

A problem is caused by the fact the agricultural machinery is still produced predominantly in small workshops; this prevents standardization of models and appropriate supply of spare parts, and the service life and value of the machinery is often low as a result of the low-quality material used. The development of the sectors preceding and following the sale of agricultural machinery, such as the supply industry, the setting-up of an efficient after-sales service and the supply of spare parts, still contains considerable shortcomings. The highly developed system of mechanics' workshops in Turkey seems able, however, to overcome fairly considerable problems as a result of its excellent capacity for improvisation.

3.1.2 Operational situation in agriculture

Agricultural mechanization takes place predominantly on the individual farms. Decisive factors for the nature, extent, speed and result of the mechanization process are, therefore, the structural preconditions, the production conditions and the farm's economic conditions.

The agrarian structure of the four countries under investigation is reproduced in a few figures in Table 2 (p. 34).

Although the overall figures for a country mean little on account of possible large differences between regions, the following nevertheless applies. In Thailand and Sri Lanka the average size of the farms is far smaller in the southern and south-western parts of the country respectively, which are mainly covered with trees and plantations, than in the agricultural regions in the other parts of the countries in question. In Morocco and Turkey the irrigated agricultural areas are contrasted by the vast dry-farming areas. Nevertheless, the figures in Table 2 show clearly that in the countries in question there are an extremely large number of farms, the overwhelming majority of which have less than 2 or 3 hectares of agricultural area. However, there are in addition – apart from in Sri Lanka, where the farms have an average size of 1.25 hectares of agricultural area – clearly several hundred thousand farms in each country which cultivate more than 5 or 10 hectares.

Another important fact concerning the agrarian structure is that ownership of land in Thailand, Morocco and Turkey is largely ungoverned (no titles to land). In all

cases a considerable proportion of farmers (often more than a third) are tenant farmers in particular on a shared tenancy or on community land, which creates unfavourable preconditions for independent mechanization.

In the countries under investigation irrigation plays an important part in increasing agricultural production; only Morocco has already equipped around 75% of the areas capable of development. The other countries are only in the initial stage of this development. The primary task is expansion of intensive farming and multiple cropping each year. Experiences to date and simple working-hours calculations show that the production potential of the present irrigation areas – and to a still greater extent that of the future areas which will be two to four times larger – can by no means be fully utilized unless there is efficient mechanization of the labour bottlenecks.

However, even in the rain-farming areas, mechanization provides a real chance to increase yields, particularly in Morocco and Turkey, where several million hectares of cereals (grain, pulse crops) can produce 25-35% higher yields, even with little natural precipitation, if technically correct cultivation is carried out in optimum time periods and harvesting and grain recovery are performed without losses by mechanized means.

In Thailand and Sri Lanka the cereal areas are smaller, but of no less importance in the "dry zones" of the north-east regions of the two countries.

The nature and extent of the available machinery varies considerably among the individual countries, although they are all only in the initial phase of mechanization. The greatest advance has been made by Turkey, where the number of tractors increased from around 240,000 at the end of 1974 to 340,000 at the end of 1977.

It is expected that between 70,000 and 80,000 vehicles will be acquired annually and that a total of one million will be reached in about ten years. The country already has one 4-wheeled tractor for about every 50 hectares of cultivated land; the engine power of the tractors is improved on average by approx. 2-3 HP (DIN) per year, while 2-wheeled tractors are practically unknown here. Combine harvesters are being used to an increasing extent, particularly in the wheatgrowing areas in Central Anatolia.

Despite many similarities, mechanization in Moroccan agriculture displays a number of fundamental differences. For years the number of tractors has been increasing only slowly and, in relation to the cultivated area, amounts to around one-fifth of the number in Turkey. Fewer tractor-drawn appliances are also used as a result of the lack of traction power. On the other hand, approximately the same proportion of the grain (just under 50%) is harvested using combine harvesters.

The situation is somewhat different in Thailand and Sri Lanka. In addition to the plantations, which offer few opportunities for mechanization, the situation is governed here by rice-growing under irrigation. To date, therefore, primarily 2-whee-

Table 2: **Data on the agrarian structure** (taken from the reports on the individual countries)

Country: / Year:		Thailand 1973	Sri Lanka 1973	Morocco 1975/76	Turkey 1975/76
a) Number and size farms					
Number of farms	(in 1000 s)	3,530	1,620	1,480 [1]	3,100 [1]
with under 3 hectares agric. area	(in %)	42.5	88.4 [2]	n.a.	52.1
under 5 hectares agric. area	(in %)	61.5	97.2 [2]	73.7	68.8
Average agric. area	(in hectares)	4.95	1.25	4.90	8.90
b) Land utilization					
Cultivated area	(in 1000 hectares)	17,490	1,995	7,295	27,700
irrigated area	(in 1000 hectares)	940	99	750	2,200
max. irrigable area	(in 1000 hectares)	n.a.	400	1,000	8,000
Extensive pastureland	(in 1000 hectares)	n.a. [3]	n.a.	8,000	17,090
Trees, plantations	(in 1000 hectares)	1,824	697	424	3,420
Main crops	(in 1000 hectares)	Rice / Maize	Rice / –. –	Grain + / Sugar beet Cotton /	Grain / Cotton
		8,895 / 720	555 / – . –	4,376 / 78	13,580 / 830
c) Machinery					
2-wheeled tractors		90,000	4,580 [4]	n.a.	∨ 1,000
4-wheeled and caterpillar tractors		30,130	10,151	21,300	340,000
Stationary threshing machines		9,680	n.a.	n.a.	21,000
Combine harvesters		n.a.	n.a.	approx. 3,000	13,000
d) Agricultural labour force	(in 1000 s)	12,050	1,620	3,630	9,700

1) Excluding approx. 450,000 and 309,000 "farms without cultivated area" respectively
2) Agricultural area of less than 2 and 4 hectares respectively (5 and 10 acres respectively)
3) n.a. = not available
4) Only 60–65% in full operating condition, some over 15 years old

led tractors, which are being manufactured and assembled to an increasing degree within the country itself, have been used in Thailand; there is, however, a clear tendency for farmers to go over to using four-wheeled tractors in the second stage of motorization. In Sri Lanka the degree of motorization is on the whole still comparatively low. In accordance with the state's intentions, the main emphasis at present is on 2-wheeled tractors (approx. 11,000 in 1976), which are used predominantly in rice-growing under irrigation, but which are also employed for transportation purposes. The number of 4-wheeled tractors has increased greatly in recent years. These vehicles were mainly used in the past for transportation, but are now also being used to a growing degree for field work in the newly-developed irrigated areas. A large proportion of the energy is still supplied in Sri Lanka by human labour and the number of persons engaged in agriculture is correspondingly high in relation to the cultivated areas occupied by the major crops. The shortage of traction power is becoming more serious as a result of the decrease in the number of water buffalo and attempts to cope with the shortage through the use of private contracted machinery are largely doomed to failure as a result of the restrictions on machine imports and the lack of tractor production in the country as a consequence of a destructive planned economy (up to the summer of 1977).

The state measures which aim to stimulate and control mechanization in the countries under investigation are of interest as regards future development of agricultural engineering. In this respect, Sri Lanka displayed the highest degree of state control and the lowest level of development. Local Cultivation Committees (CC) have been set up here, which in turn are organized at a higher level in Agricultural Productivity Committees (APC). The CCs and APCs were intended to be responsible for agricultural development and at the same time to be the targets of the control and supervision exercised within the framework of the planned economy, but have so far been unable to perform this funtion as planned.

In the other three countries the major burden of technical development is borne today by the private farms and, to a small extent, by the cooperative and state farms. As a result of the agrarian structure, which is oriented towards small farms, the use of contracted machines by large farms and non-farmers is of great importance. State promotion is essentially limited here to low-interest loans and subsidies (up to 30%) which are, however, provided only to an inadequate extent for investment purposes. The loans in question are mainly production or even consumer credits. The exceptional advance in mechanization made by Turkish agriculture (since 1974) can, therefore, be explained only by the availability of adequate private sources of finance and loans in the richer regions and on the richer farms.

In Morocco the state introduced initial mechanization, up to about 1970, by means of low-cost machine services via the Centres de Mise en Valeur (CMV) in the irrigated areas and via the Centres de Travaux (CT) in the rain-farming areas. It has recently cut back on this uneconomical promotion measure and is endeavouring, by means of assistance to "Groupements des Motoculteurs" and cooperatives, to develop a private-enterprise form of organization alongside the use of contracted machines; little success, however, has been achieved to date.

In all countries investigated the most important area of mechanization, in terms of private benefit through increased income and national economoc benefit through increased production, has proved to be tilling of the soil to ensure proper working of the fields at the correct time. Under most conditions, faster harvesting and processing of the harvest constitute the second most important area of mechanization. Mechanization of sowing and fertilizing is given only third-degree priority and its importance varies. Transportation and crop protection occupy a special position and are usually of considerable importance beyond actual cultivation of the fields, since transportation equipment (tractors and trailers) not only speeds up transportation of persons and material on the farm, but can also help to provide an additional income by means of use off the farm. The most intensive crop protection programmes are used where shrubs, trees and vegetables are being cultivated and can be properly implemented only if the correct technical equipment is available. There is almost no mechanization of forage growing or the keeping of heavy livestock. The beginnings of development in these fields are to be found only in Morocco and Turkey.

The situation as regards availability of a technology appropriate to national conditions is more or less inadequate in all cases. However, particular problems occur in the case of specific products, e.g. in the sugar beet and cotton harvests. To date it has also been impossible to find a low-cost mechanized harvest technique for maize and rice. The development of a simple small tractor has so far been able to bring about only a small reduction in the gap between the small farmer's growing need for traction power and the services of the machine contractors at current market prices.

In none of the countries investigated – apart from Turkey – were there signs of appreciable efforts in the field of technical development with appropriate public support, a deficiency which seriously inhibits development of a nation agricultural machinery industry producing equipment at a lower cost.

The actual situation in the individual countries as regards agricultural mechanization may be summed up as follows:

In Thailand – except in the relatively prosperous central region – manual labour predominates; working animals (buffalo) are used in tilling the soil, transportation and threshing work.

Starting from the central region a gradual mechanization process, mainly using 2-wheeled tractors, has been set in motion, but is progressing only slowly due to the insufficient profitability of rice production. Some of the modern irrigated areas are making more rapid progress and are already making the transition to 4-wheeled tractors. The increased amount of traction power available promted many landowners to take back areas which they had let out on a tenancy or shared tenancy. The other side of motorization, in terms of social effects, was thus an increase in the landless and jobless rural population. No reversal of this trend can be expected so long as there is no transition from single to multiple cropping, which represents the main opportunity for development.

In Sri Lanka agriculture ist dominated by the plantations with their low mechanization requirements. Nevertheless, the poor food production in the remainder of the agricultural sector (rice, grain, pulse crops, vegetables etc.) can be considerably improved if appropriate use is made of the available rainwater in modern irrigated areas, a process which is already under way. In order to cope with the work involved in this, advances must be made in mechanization – which is still inadequate – in the major area of field cultivation. Increased use of 2-wheeled tractors, which already suggests itself today and gives proof of economic benefit, does not release a labour force of any appreciable size, since multiple cropping is possible to a greater extent in this country with its small land resources and is also better known there than in Thailand with its larger area.

Moroccan agriculture has adapted to modern mechanization, since it has proved economically profitable, in both irrigated cultivation and rain-farming; the principal need for mechanization, however, is in the irrigated areas which in the future will cover one million hectares of land under intensive cultivation. The machinery available today is to a large extent still inadequate and comprises only part of the equipment which will probably be necessary. The small-farm-oriented structure, combined with a poor infrastructure and relatively expensive (imported) tractors means that the changeover to higher levels of mechanization can take place only slowly. A considerable proportion of the natural yield potential will thus not be fully utilized for a considerable time. Apart from a few industrial crops, agricultural production has largely stagnated in recent years. A disproportionate increase in farm workers' wages during peak labour periods will force mechanization, particularly in tending and harvesting important crops (sugar beet, cotton, vegetables), unless it is intended to limit the areas coverd by these crops.

Turkey is a typical "threshold country" in which intensive agricultural development – involving both expansion of agricultural areas and an increase in yields – has been in progress for a number of years as a result of a variety of factors. The favourable conditions for effective operation simultaneously stimulate the use of better-quality seed, of fertilizers and crop protection agents and increase the profitability of mechanization. Particularly favoured by this are the Sea of Marmara, near the Aegean Sea and around the Mediterranean; the graingrowing areas of Central Anatolia, which are also somewhat favourable, additionally derive benefit. In these areas it is already possible to find peasant farms with a high level of mechanization in addition to the large state farms. On the other hand, the figures of over one million wooden ploughs and the same number of threshing slides and over six million horses, mules and oxen show that traditional methods with high labour requirements are still practised to a considerable extent. The very small farms, which number around 1.5 million, mostly lack all the requirements which would enable them to join in an economic development process through their own efforts.

3.1.3 Situation and development in the training sector

The level of education and the training requirements in the agricultural sector are major framework conditions for the planning, organization and implementation of external promotion measures in training and upgrading. The situation in the four countries under investigation may be characterized as follows (cf. Table 3, p. 39):

The starting position for the setting-up and development of an efficient primary school system varied greatly between the countries investigated. Morocco and Sri Lanka took over the school system used in colonial days, while Thailand and Turkey built up their systems by themselves, Turkey on a completely new basis and Thailand on the basis of the monastic schools. All four countries today spend a disproportionately large amount of their budget on the primary school system, mainly with the aim of preventing the danger of illiteracy among the ever-increasing younger generation. In Thailand, Morocco and Turkey compulsory education ends with the primary school; only in Sri Lanka is it extended to nine years through an additional four years of secondary level I.

In all four countries the rural population has as a rule attended primary school for no longer than four or five years. Moreover, particularly in the sparsely-populated rural areas, primary school education is of an extremely low standard due to the continuous migration of teachers and lack of equipment. Illiteracy is still widespread amoung the older rural population. The illiteracy rate is highest in Morocco; in Turkey is was approx. 35% in 1975.

As a result of the short period of compulsory education and the other above-mentioned conditions the rural population in the countries in question is generally but little qualified to take advantage of educational and vocational upgrading measures in agricultural engineering. This has a noticeably inhibiting effect on, among other things, the introduction of agricultural mechanization and necessitates training measures geared to these factors.

The demand for a higher level of education is extremely high among young people in all the countries investigated. It is reflected in an ever-increasing growth rate for the secondary school system, although admission is restricted by means of entrance examinations at both the lower and higher levels In the countries under consideration here the secondary education system is divided up into general and vocational secondary schools. In most cases the former lead directly to university or college study, while the latter are intended to provide direct training for skilled workers but are often used to enable students to enter specialist colleges.

The vocational secondary schools enjoy as a rule less prestige than the corresponding general schools and are avoided if possible by the young people, at least at the lower entry level. They are intended to train the urgently-required skilled workers, but are able to meet the requirements of this task to only a small extent. In all countries investigated the schools are too heavily burdened with general subjects and suffer from a lack of facilities for practical training and a serious shortage of

Table 3: **Structural data on the education system as a framework condition for agricultural mechanization**

	Thailand	Sri Lanka	Morocco	Turkey
1. Primary school Length of primary education; features typical of the country	7 years, well-developed; state schools in the country's regions, effectively complemented by monastic schools	5 years, well-developed, English now 1st foreign language; all pupils go on to secondary level I	5 years, development suffering due to withdrawal of French teachers, growing Arab influence and much migration from rural areas, many pupils break off education	8 years, well-developed, even in rural areas; aided by good teacher training
Teachers	Large number available, plus many monks	Available	Low standard following departure of French teachers	Own teacher-training colleges and departments
2. Secondary school system (sec.)	Rapidly built up due to economic boom	Greatly developed since 1972, policy of reform, 9 years of education for all	Undergoing development since it enjoys high prestige, approx. 94,000 (36%) of primary school pupils progress to secondary education	Great demand, at present: 930,000 pupils in sec. level I 240,000 pupils in sec. level II
Duration, levels	6 years, 2 levels, 3 branches: upper level 2 years (general), 3 years (vocational)	6 years, 4 years lower level, 2 years upper level, admission via entrance examination	7 years, 4 years lower level, 3 years upper level, admission via entrance examination	8 years, 3 years lower level, 3 years upper level
General/ vocational	General, full-time vocational schools, comprehensive schools, 211 state vocational schools according to statistics	General, a few private vocational schools (trade schools)	Lower level general, upper level 3 branches of study	Low attendance of vocational schools in sec. level I because unattractive
Final examination, qualifications	Yes, entitles pupils to take university entrance examinations	Sec. level I: G.C.E. Sec. level II allows pupils to take university entrance examination; qualification: Technician	Sec. level I = agents techniques etc. Sec. level II = adjoints techniques etc.	Yes, completion entitles pupils to take university entrance examination
3. Agricultural schools; Responsible authorities	31, another 10 planned, Ministry of Education: Department of Vocational Education (DOVE)	4 at sec. level I 1 at sec. level II Ministry of Agriculture	4 following primary education (1 year), 8 following 11th class (2 years), Ministry of Agriculture	Ministry of Agriculture; approx. 12 at sec. level II, many attached to state farms
Technical specialization	Regional specialization, all with general agriculture	Several departments, scattered throughout the regions	Technical and regional specialization	Regional and technical; 3 agricultural schools, including 2 German-Turkish
Breakdown of subjects Practical training	Approx. 30% general subjects Approx. 30% general agriculture Approx. 20% specialized agriculture Approx. 20% practical exercises 3 months practical training	Similar to Thailand, Practicals and agricultural engineering under development in Anurathapura	Similar to Thailand	See elsewhere 40-55% general subjects 45-30% agricultural subjects 15% practical training (last year)
Qualifications	Upper level: Technician	Technician	See above	Technician, if agricultural engineering school
4. Agricultural colleges and faculties	Own agricultural university with several faculties in Bangkok	1 national university with Faculty/Department of Agriculture, regional department	Hassan II Agricultural College to produce qualified agricultural engineers	Several agricultural college and faculties
Departments or faculties	Additional Faculties Agriculture planned in Chieng-Mai and Songkla, numerous institutes throughout the country	Limited number of places, entrance examination, long waiting list of applicants, potential unemployment	General Agriculture, Agricultural Construction, Hydraulic Engineering and Forestry; Veterinary Medicine; plus 4 higher agricultural colleges	Agricultural engineering departments under development (Izmir etc); agricultural students underrepresented (2,8%); also as graduates
5. Vocational training and upgrading	Takes place almost solely at full-time colleges, technical training centres run by numerous authorities, also private initiatives; no national vocational training system, international assistance	Remainder of old vocational schools, now N.A.B. = National Apprenticeship Board, responsible for all vocational training. Priority: combatting youth unemployment	Takes place almost solely at full-time colleges, heavy influence of French education system, no national system to date or cooperation with private enterprises	Legal basis recently created, dual system; vocational schools at sec. levels I and II, little demand for level I
Situation in the German- . . . project	Up to 1976: mainly formal training of college students in agricultural engineering; from 1977: mainly informal training	Vocational training in technical aspects of agriculture outside the formal training system	Formal training, specializing in agricultural engineering, 1 of the 8 college with 2-year period of instruction (Lycee)	Much informal training in addition to formal training at agricultural engineering college; from 1976: higher agricultural engineering school and informal training as previously

suitably-trained teachers and instructors. In view of the fact hat they moreover provide qualifications which are rated very low in the social hierarchy, they are attended by an inadequate number of pupils. This results in an extensive shortage of qualified skilled workers in technical jobs in agriculture, which has considerable negative effects on the productive services area of the agricultural sector.

As already stated, the vocational secondary shools at the higher level lead, as a rule, to a college place. Moreover, they mostly provide useful qualifications (Technician etc) and thus facilitate direct access to much sought-after jobs in public administration. This applies in particular to the higher agricultural schools, which, to varying degrees, provide in all four countries the younger generation of staff for the greatly-expanding agricultural administation. The increased knowledge and improved skills provided by secondary school education benefit the rural population only indirectly through the use of the former pupils as technicians, advisors and officials in the state agricultural administation system. The influence on the farmers and their level of knowledge to be achieved in this way is not only considerably slowed down, but is also relatively small if the agricultural administration personnel lack practical training and experience.

All the countries investigated have agricultural colleges or faculties with various specialist departments, which train skilled personnel for the individual branches of agriculture. However, only in the agricultural colleges and faculties in Turkey are there departments of agricultural engineering, which impart to the future graduates in agriculture a higher proportion of knowledge and skill in agricultural engineering and can also ensure that they are qualified to perform research work, such as the testing and development of agricultural machinery.

In Morocco, Thailand and Sri Lanka agricultural engineering training at university level is still in the initial stage of development. This means that for some time to come these countries will be able to meet the training requirements of agricultural engineering graduates only by means of additional upgrading of the skilled personnel already engaged in their profession.

In conclusion, the training situation in the four countries investigated my be summed up as follows:

Thailand, Sri Lanka, Morocco and Turkey are carrying out modernization and rationalization of agriculture to varying extents. Their targets and strategies include measures for improving job-related training, because they have realized that the production of skilled workers with a good vocational training is of vital importance for agricultural promotion.

At present, however, the facilities afforded by the formal education system in all four countries are unable to supply, in terms of either the right quality or quantity, the skilled workers required for further development of agriculture. This applies particularly to the field of agricultural engineering; the development of a national vocational training system outside the formal education system on the basis of

short-term programmes (i.e. informal jobrelated training) is, therefore, of particular importance.

To date, only Sri Lanka and Turkey, of the countries investigated, have started to create a system of this type. The introduction of informal training courses in agricultural engineering is to be included. In Thailand development of a vocational training system of this type has only recently been started and in Morocco nothing has been done in this field to date.

A special vocational training system, adapted to the requirements of the country in question and including agricultural engineering, would benefit agriculture in two ways. On the one hand, it could produce technically qualified skilled workers for the maintenance and repair of agricultural machinery (technical workshop training), workers for whom there is an ever more urgent need in view of the increasing mechanization. On the other hand, an efficient informal training system could provide the rural population with improved professional and technical knowledge on modern cultivation methods and the practical use of machinery (technical agricultural knowledge).

3.1.4 Situation and development of agricultural advisory services

In comparison with educational institutions, a characteristic feature of agricultural advisory services is that under normal conditions they deal with actual practical problems and produce more rapidly visible results when solving them. In the event of changes in conditions it is relatively easy to alter the targets of the advisory services. They also reach a large number of people; this also applies, in general, to the developing countries.

Each of the countries investigated has a state agricultural advisory service, in all cases supplemented only to a small extent by semi-governmental and private institutions.

Table 4 (p. 43) indicates a number of features of the advisory services in the countries in question.

As a rule, the state advisory service is fully integrated into the Ministry of Agriculture or the organizational units under the control of the Ministry. In Turkey, however, the organizational framework is broader; a variety of ministries, each with its subordinate agencies, handle the agricultural advisory services, depending on the topic of the advisory assistance to be given. The resulting unclear division of responsibilities probably leads to overlapping of functions, less efficiency and contrary decisions.

In all countries investigated the state advisory service has a hierarchical structure but is subject to central control, particularly in Thailand and Morocco. Particular

attention should be drawn in this connection to a certain degree of dualism in the advisory services in Turkey and Morocco, where the irrigated areas are given priority treatment and are looked after by a generally adequate number of qualified advisors and special advisors, while the traditional rain-farming sector is seriously neglected. In these areas the ratio of advisors to farmers is particularly inadequate; no reliable data on this are available for Morocco or Turkey. In Thailand one advisor caters for approximately 4,500 farmers. The best situation is still that in Sri Lanka, where one advisor must provide a service for only 1,000 farmers.

The ratio of advisors to farmers must be seen in conjunction with the advisory methods used. In the irrigated areas of Turkey and Morocco, and in Sri Lanka, individual advisory assistance – within a variety of different organizational structures for the individual consultancy services – is given equal priority alongside advice to groups of farmers. Otherwise emphasis is placed on group advice due to the low ratio of advisors to farmers. The advisory assistance is aimed at groups which are as uniform as possible or which comprise farmers with similar interests. The vast majority of farmers benefit little or only inadequately from the advice given under this system.

Except in Thailand radio and – if available – television are being successfully used to an increasing extent to provide advice and information for farmers. In all countries advisory assistance in agricultural engineering matters which, except in the irrigated areas of Turkey and Morocco, exists only in a rudimentary form, is aimed very one-sidedly at increasing production. There is almost no consideration of the actual situation on individual farms.

Agricultural advisory services by semi-governmental and private organizations, particularly cooperatives, are generally concentrated in all four countries on advice on cultivation or on the use of individual products or appliances in which the institution concerned has a particular interest.

In all four countries the advisory system ist characterized by the fact that the advisors act to a large extent as the extended arm of the state and are primarily concerned in fulfilling its plans and implementing its developments. They afford little real help towards self-help and provide productrelated advice, giving priority to the government's agricultural policy aims. This damages the relationship of trust between advisor and farmers and means that a considerable proportion of working hours must be used for activities other than provision of advisory services.

The efficiency of the advisory services in all countries visited continues to be hampered to varying degrees by:

- inadequate level of training on the part of the advisors,
- poor supply of equipment to aid the consultancy service,
- inadequate provision of means of transport and
- lack of readiness on the part of advisors with a high level of general and specialized training to operate at a lower level.

Table 4: **Features of the advisory services in the countries investigated**

Features	Thailand	Sri Lanka	Morocco	Turkey
Institutional embodiment and control	Ministry of Agriculture, centralized control	Ministry of Agriculture, decentralized control	Ministry of Agriculture, centralized control	Various ministries, unclear division of responsibilities
Ratio of advisors to farmers	Approx. 4,500 farmers per advisor	Approx. 1,000 farmers per advisor	High in irrigated areas, very low in rain-farming areas	High in irrigated areas, very low in rain-farming areas
Advisory methods	Mainly advice to uniform groups	Individual and group advisory assistance have equal priority irrigated areas, otherwise only group/mass-approach advisory method	Individual and group advisory assistance have equal priority in irrigated areas, otherwise only group/mass-approach advisory method	Individual and group advisory assistance have equal priority in irrigated areas, otherwise only group/mass-approach advisory method
Main emphasis of advice	Mainly irrigated agriculture; heavily crop-related and geared to the state's agricultural policy targets; operational situation on farms ignored			
	No advice on agricultural engineering to date	Only isolated beginnings of agricultural engineering advice	Agricultural engineering advice available only marginally in irrigated areas	Beginnings of agricultural engineering advice in existence
Personell, organizational and institutional shortcomings	Performs functions other than advisory assistance, lack of technical skill, too few special advisors, unclear devision of responsibilities, lack of targets and detailed planning, lack of coordination with other promotion institutions	Performs functions other than advisory assistance; in some cases advisors lack technical skill; poor equipment; lack of co-operation between research and advisory personnel, too little practice-related upgrading	Severely burdened by organizational and administrative work; inadequacy as regards technical skill of advisors and lack of commitment; unrealistic targets; lack of coordination with other promotion institutions	High degree of dualism between administrative and advisory work; training of advisors too theoretical; overlapping responsibilities and lack of coordination of activities by various sponsoring organizations; inadequate promotion and salary opportunities; no mobility due to lack of transportation; lack of equipment
Planning and programmes for improving the advisory service	Reinforcement and improvement of management at headquarters; implementation of clear guidelines and directives; enlargement and better qualification of advisory staff, organization of practice-related training and upgrading of advisors; introduction of situation-related advisory methods and concrete action plans, preferential collaboration with contact farmers	Redistribution of activities and measures to improve beginnings of advisory assistance and quality of advisors; practice-oriented training of advisory personnel; increase in mobility and better provision of equipment aiding advisory work; intensified collaboration with contact farmers; creation of extension serving units	Establishment of a coordinating committee at national level; enlargement of advisory staff and improvement of training and upgrading of advisors at the planned advisors' training centre; service no longer to perform functions other than advisory assistance; inclusion of farm management and agricultural engineering problems; increased services in rain-farming areas	Setting-up of an institute for agricultural advisory services; introduction of a preparatory service period for advisors; setting-up of 4 training centres for upgrading advisors; decentralization of advisory service and introduction of team-work in the form of specialized groups; improvement of social status of advisors and better provision of equipment aiding advisory work

The poor standard of training of the advisors, particularly at the lower level, is caused by the same factors everywhere. These ar:

- poorly-equipped colleges with out-of-date curricula and many unqualified instructors,
- lack of training in advisory methods and didactics,
- too low a level of training (specialized and otherwise) set as a standard for a career in the advisory services,
- lack of qualifications on the part of the advisors' instructors,
- inadequate opportunities for furter training and upgrading.

The situation as regards advisory services in the four countries investigated may be summarized as follows:

Thailand

On the basis of a pilot project and with the involvement of progressive and open-minded farmers a comprehensive advisory project is being started up with the assistance of the World Bank. It is intended that it should lead to a fundamental improvement in the advisory services and concentrates on the following areas:

- improvement of management at headquarters and implementation of a clear plan for guidelines, coordination, supervision and realization,
- increase in the quantity and quality of the advisors,
- introduction of a situation-related advisory method and action plans for individual advisory endeavours,
- increase in efficiency through the involvement of and cooperation with "contact farmers",
- improvement of the reciprocal flow of information to and from the experimental stations,
- improved provision of direct and indirect aids for the advisors.

These measures are so radical and comprehensive that if it is possible to implement them as planned, efficiency will be considerably increased and cooperation improved within the Thai advisory service. However, the reorganization plans do not provide for the setting-up of an agricultural engineering branch of the advisory service or the determination of particular areas of emphasis in the direction of economic advisory services, which would be particularly important in the light of the rapid and uncontrolled progress of mechanization in this country.

Sri Lanka

A reorganization plan for the responsible department provides for reassignment of activities and measures to improve the beginnings of the advisory work and its quality, so that programmes concerning agricultural policy and economics may be implemented more rapidly and successfully.

The plan, whose feasibility and success potential is being tested in one of the 22 districts, is aimed at making research, training and advisory work more efficient and improving coordination. With support in the form of equipment and personnel from the United Nations Development Programme (UNDP), the International Development Association (DA) and the Food and Agriculture Organization of the United Nations (FAO) the government intends to take the following steps in this connection:

- creation of an information centre at the Department of Agriculture,
- qualitative and quantitative improvement of the available advisors,
- organization of regular, practice-oriented upgrading of advisors, particularly those at the lower level,
- release of the advisors from work other than advisory activities and improved coordination of the work of all persons concerned with the provision of advisory assistance at district level,
- improvement of the advisors' mobility and provision of aids for advisory word.

Implementation of this plan depends on whether the personnel and financial preconditions are successfully created.

Advice on agricultural engineering questions is at present being introduced through the gradual provision of an agricultural engineering advisor for each District Extension Centre. However, the sphere of activity of these advisors has not yet been specified in greater detail. The planned assignment of 15 additional special advisors on crop protection — supplemented by support from the FAO — is intended predominantly to ensure greater efficiency in agricultural engineering advisory work within this specialist field.

Morocco

The dualistic organizational structure of the advisory system, comprising

- the modern irrigated agriculture sector within the Office Regional de Mise en Valeur (ORMVA) and
- the traditional sector under the provincial administrations,

ist to be maintained.

The shortcomings of the advisory service are, however, to be reduced or eliminated by means of the following measures:

- improvement of management and coordination,
- quantitative and qualitative improvement of the advisory staff,
- increased inclusion of farm management and agricultural engineering elements in the advisory work,
- release of the advisors from activities other than advisory work,
- improvement of advisory work by means of increased use of advisory methods and through the formulation of target-oriented action plans.

In conjunction with the reorganization of the state advisory service it is also planned to set up an agricultural engineering branch of this service, which is to operate among the machinery cooperatives.

Turkey

The plans and measures introduced in Turkey aim above all at streamlining and intensifying the agricultural advisory service. In the administrative sector the present confusion as regards responsibilities is to be eliminated and the advisory work made more efficient by means of clear organization and removal, at least in part, of the burden of administrative work.

In the personnel sector more stringent requirements are to be made when appointing advisors as regards qualifications for the job, particularly as far as practical work is concerned, and the necessary preconditions for this created in training and subsequent areas. In addition to technical questions, upgrading measures are also to cover advisory methods and related fields.

3.2 Features of the projects investigated

In the field of agricultural engineering, Technical Cooperation projects can in principle be planned and implemented in the form of projects involving either development, adaptation and testing of technical equipment and appliances or training and advice concerning their use. There are close interdependencies between the two fields insofar as the consistency and efficiency of activities in one project area depend on the mode of action and scope of effect of the other. This applies at least wherever development and testing work in the field of agricultural engineering are necessitated by or appear appropriate in the light of a country's specific conditions and wherever the multifaceted nature of the problems and greatly varying conditions prohibit from the outset a "mixed" project, which is usually the case.

The assistance given in the field of agricultural engineering in Thailand, Sri Lanka, Morocco and Turkey within the framework of Technical Cooperation by the Federal Republic of Germany consists of pure training and advisory projects.

In the four countries investigated state-run institutions and facilties for the development, adaptation and testing of agricultural machinery are already in existence or are being built up. The impetus which they give to mechanization is, however, in all cases somewhat weak.

3.2.1 Objective and functions

The projects in Thailand, Sri Lanka, Morocco and Turkey must be considered against the following background:

None of these countries has a national mechanization programme which takes into account production and operational requirements and the economic and social targets. Nor is there, therefore, an overall policy which makes it possible to embody development aid measures from outside in a general plan or to make them part of a consistent strategy. The targets and terms of reference for each individual project were, therefore, set on the basis of agreement between the partners and with regard to the need to meet generally existent training and advisory requirements without precise knowledge of the promotion effect which could be achieved.

From the point of view of the Federal Republic of Germany, the general target in the case of all four projects was to aid in increasing and intensifying agricultural production and improving incomes by increasing the knowledge and skill in agricultural engineering possessed by the groups of people involved in the development process. However, training projects cannot directly fulfil this general objective of development policy, since, in principle, they lead only indirectly to economic and social benefit.

This fact is an important criterion for assessing agricultural engineering projects, because, depending on the approach, nature and course of the mechanization, the economic targets and possibilities of an increase in individual income may conflict with social requirements such as job creation, participation in progress by broad sectors of the population, division of wealth etc. Conflicts of this type occur in particular if — as is the case, for example, in the countries investigated — the government in question does not establish a systematic and consistent mechanization policy. Individual and overall economic benefit brought about by technical progress must, however, be in balanced relation to social requirements. Agricultural engineering development projects can contribute to this only if their measures are aimed in this direction.

The analysis of the projects investigated produces the following picture of the actually feasible objectives, targets and functions (cf. Tabe 5 on page 49).

In the Thai project at Pathumthani the original objective was predominantly informal training at national level. The efforts made towards mechanizing Thai agriculture were to be supported by means of training and advisory measures concerning the use of technical aids, servicing, maintenance and repair of agricultural machinery and appliances and selection of economical mechanization methods. The basic idea was thus selective promotion of the use of machinery and achievement of a direct effect on the machinery users. In view of the size of the country this was certainly an extremely long-range and problematic target. However, the situation became still more problematic when, during setting-up and implementation of the project – the above aim still being maintained – there was a clear shift in activities towards formal training in the shape of a two-year course for students who had completed training at an agricultural college. Only following an interruption and a resumption of work was it possible to realize the original aim as from 1976.

The Anuradhapura project in Sri Lanka had similar targets. Here it was the task of the agricultural engineering training and advisory centre to make both farmers and tractor drivers (i.e. "final consumers") and agricultural teachers, advisors and students throughout the country familiar with agricultural engineering knowledge and skills by means of informal training. This was also to be done in the case of skilled technical workers such as charge hands, mechanics and other workshop personnel.

The project's advisory activities were to comprise the following tasks:

- planning and setting-up of five state farm (and training) workshops, plus organization, advice and assistance in their work and teaching and in spare part acquisition to improve techniques and efficiency in the state repair service, and in training in repair techniques at individual centres providing formal and informal training;
- advice and assistance to agricultural training institutions, such as the university's Institute of Agricultural Engineering, the agricultural college, farm schools, in-service training centres and regional training centres, as regards the implementation and improvement of agricultural engineering instruction in theory and practice (planning, content and holding of instruction).

These tasks have not changed at all; the overall task of the project remains as described.

In contrast to the projects in Thailand and Sri Lanka, the project in Morocco has a different target and different tasks. The project aims to carry out two-year training of technical specialists of the lower technician grade within the prevailing hierarchy of the formal agricultural training system. The main emphasis is on the training of workshop foremen and instructors for agricultural machinery mechanics. Organization of this training at national level serves mainly to contribute towards meeting the considerable requirements for state specialists in the servicing, maintenance and repair of tractors and agricultural machinery. The project activities do not involve advisory work.

Table 5: **Targets, tasks, institutional embodiment and duration of the project investigated**

	Thailand	Sri Lanka	Morocco	Turkey
Sectoral/sub-sectoral aim	Supporting efforts towards agricultural mechanization by means of training and advisory measures in agricultural engineering	Promoting appropriate mechanization of agriculture and increasing the income of small farmers by means of training and advisory assistance in agricultural engineering	Increasing agricultural production by training workers skilled in agricultural engineering for the machinery stations run by the Ministry of Agriculture and its agencies	Contribution towards technical and economic development of agriculture by training workers skilled in agricultural engineering
Direct targets and tasks in project phase 1	Imparting agricultural engineering knowledge and skills in maintenance, use and repair of agricultural machinery to teachers of agriculture, advisors, students and other groups at national level and on the basis of informal training programmes; advice to agricultural schools on problems concerning agricultural engineering training; transition very soon to 2-year formal training in agricultural engineering for students completing training at an agricultural college	Imparting agricultural engineering knowledge and skills in maintenance, use and repair of agricultural machinery to teachers of agriculture, advisors and students, together with farmers, tractor drivers and mechanics, at a national level and as part of informal training programmes; planning, setting up, advising and supporting 5 state farm and training workshops; advising and assisting agricultural training institutes at various levels in the implementation and improvement of theoretical and practial teaching in agricultural engineering	Training agricultural engineering specialists for the state agricultural engineering repair service as part of a formal training programme (training period 2 years, final qualification: adjoint technique de la mechanique agricole); also training of workshop foremen and teachers from agricultural schools. No advisory activities.	Imparting agricultural engineering knowledge and skills in maintenance and use of agricultural machinery to teachers of agriculture, advisors and farmers as part of informal training programmes; main emphasis on training "multipliers"; also taking-over of agricultural engineering teaching at an agricultural school within framework of formal training programmes. Advice to local farmers serves mainly to help familiarize instructors with the practical situation. Upgrading of counterparts within the project and in the Federal Republic of Germany.
In project phase 2	Mainly formal 2-year training in agricultural engineering for students completing training at an agricultural college; plus short courses (during vacations) in servicing, maintenance and use of agricultural machinery for teachers and advisors involved in agricultural engineering, farmers and students. Advice to agricultural schools on cultivation and use of machinery on a small scale; implementation of land improvement measures for agricultural schools and maintenance and repair of earth-moving machines. Training and upgrading of counterparts within the project and in the Federal Republic of Germany.	As in project phase 1, but emphasis on training of "multipliers" and intensive counterpart training within the project, plus training of same in the Federal Republic of Germany.	As in project phase 1, plus training and upgrading of counterparts within the project and in the Federal Republic of Germany; holding of a number of short courses, for teaching and advisory personnel	Tasks expanded to include long-term training of agricultural engineers (4-year training leading to qualification as technician) within framework of formal training programmes. Subsequent employment of students completing course solely as agricultural engineering teachers and advisors. Creation of an institution acting as a model for further equivalent training centres, plus provision of standardized teaching documentation and working aids.
In project phase 3	Renewed approach to original targets: holding of upgrading and short courses for teachers and students at agricultural schools, farmers and personnel from agricultural authorities; simultaneous reduction of German involvement	As in project phases 1 and 2, but with extremely intensive activity in production of course documentation and working aids; simultaneous reduction of German involvement	As in project phases 1 and 2, plus follow-up supervision of former students at their place of assignment with the aid of a travelling workshop; however, simultaneous reduction of German involvement	According to planning, same as project phase 2. Creation of an additional training field: "Mechanization of agriculture", setting-up of a teaching aid centre in Ankara, follow-up supervision of the Gölbaşı agricultural engineering school.
Institutional embodiment, responsible authority and approach	Ministry of Education, Department of Vocational Education, fully integrated into the hierarchy of the formal training system; approach at national level	Department of Agriculture, Section Education and Training, area dealing with informal training; approaches at national and regional level	Ministry of Agriculture, Department of Vocational Training, fully integrated into the hierarchy of the formal training system; approach at national level	Ministry of Agriculture, Directorate-General for Agriculture – Training Devision –, partially integrated into the formal training system; approaches at regional (and national) level
Schedule Start of planning Start of implementation Probable end of German involvement	1964 End of 1969 End of 1980	1969 Mid-1971 Mid-1980	1969 Mid-1970 July 1979	1972 Mid-1975 Undecided

In Turkey (the Söke project) a regional development approach with broad terms of reference was chosen. In general, the technical and economic development of agriculture is being promoted through the training of skilled workers for the field of agicultural engineering, particular attention being given to the mechanization of irrigated agriculture.

The training is being carried out via an agricultural engineering project based at a school of agricultural engineering which developed from a school of agriculture. This school provides both training for farmers from the surrounding areas and upgrading of agricultural specialists from the local agricultural administrations, together with upgrading of teachers of agricultural engineering at agricultural schools in all fields of agricultural engineering.

Advisory work is limited to the farmers in the immediate vicinity. It does not represent a major activity of the project and serves primarily to improve the agricultural engineering instructors' contact with actual agricultural practice.

In 1978 the functions of the Söke project were expanded to include long-term training of agricultural engineers with the emphasis on the use, servicing and maintenance of agricultural machinery, in the form of a higher agricultural engineering college; it is intended that the students should be subsequently employed as teachers or advisors in the agricultural administration. In the future this college in Söke is to be developed into a crystallization point for agricultural engineering training throughout Turkey (training of intermediate-level agricultural engineers; a model for any other agricultural engineering training centres which may be set up).

Seen as a whole, the targets and tasks of the four projects investigated may be characterized as follows:

A multi-level development approach, involving training and upgrading of groups of persons with various areas of activity and functions, was chosen in Thailand, Sri Lanka and Turkey. It attempts to meet the need for personnel trained in agricultural engineering at various levels, depending on the country's requirements. It is notable that in accordance with their objective, these projects concentrate on training skilled personnel who are intended to pass on the knowledge which they have acquired to professional colleagues and farmers – thus creating a multiplication effect – within the framework of both informal and formal training programmes.

In Morocco, on the other hand, the development approach is aimed predominantly at direct practical employment in government or semi-governmental institutions.

3.2.2 Institutional embodiment and approaches

If development projects do not have a special status as a result of corresponding agreements, they require an administrative framework and must be integrated into

the organizational structure of the country in question in order to avoid confusion as regards responsibilities, partnership in terms of finance and personnel, the authority to issue instructions and cooperation possibilities etc. Institutional embodiment of development measures is a major determining factor as regards the actual opportunities for performing the tasks set and is at the same time one of the decisive factors in the choice of the approach and the opportunities for putting it into practice.

If a project has the right institutional basis, the local body bearing the responsibility for it endeavours as a rule to give it energetic support as befits its importance and to continue it in accordance with the value placed on it once it has been handed over. If, on the other hand,a project has been given the wrong institutional basis, this often means that the objectives cannot be properly pursued, and that the project has an inappropriate form of organization and location, together with an inadequate or slow supply of resources and personnel. As a result of this the targets set may be achieved only to an inadequate extent or not at all or the development of a project may be directed the wrong channels. Often, desired and desirable training results can be achieved either not at all or only after some delay with considerable losses in efficiency. In addition, projects with a poor institutional basis give rise to normally avoidable personnel and financial problems which jeopardize the existence of the project in the long term.

An analysis of the situation in the training centres investigated produces the following picture:

In Thailand the Thai-German Agricultural Engineering Training Centre (AETC) at Pathumthani is fully integrated into the Ministry of Education and the hierarchy of the formal agricultural training system.

Such a set-up inevitably results in administrative problems which can be satisfactorily overcome only with first-rate cooperation between the various ministries and departments concerned and excellent contacts with the institutions which designate the skilled workers to be trained and/or later employ them. It was due not least to the institutional integration that, on the basis of the wishes and targets of the local project partner, the original objective, which aimed at rapid propagation of the technical knowledge imparted, was altered in favour of long-term training of students. Although the approach resulting from this change led to clearly outlined and defined fields of activity for the German experts, it nevertheless used up available capacities to a large degree, so that additional short courses in the maintenance, repair and use of agricultural machinery for teachers of agriculture, agricultural advisors and farmers could be held only to a limited extent. The situation was made more difficult by the fact that a soil laboratory and a central agency for the repair and use of heavy cultivators for land improvement measures, neither of which served the purpose of agricultural engineering training, were attached to the training centre.

If a project approach at national level, geared principally to training the "final consumers", could not be realized in itself, the above-mentioned changes in the experts' activity moved still further away from the objective. This situation was corrected by

means of a complete transition to informal training when work was resumed in 1976. Moreover, the fundamental problem – the fact that only "multipliers" can be the direct target group in national training programmes – has been partially solved by holding more courses in the rural areas and directing these at farmer formen and pilot farmers (multipliers at the lowest level).

In Sri Lanka the Farm Mechanization Training Center (FMTC) at Anuradhapura is fully integrated into the section responsible for training and advisory work in the Department of Agriculture, which is responsible to the Ministry of Agriculture. The overwhelming majority of the skilled workers suitable for training in the form of short courses are nominated by this Department or the agencies under it and employed by the Department once they have completed their training.

In this field the Department works in close cooperation with the project's training centre and also provides training programmes for other governmental and semigovernmental institutions involved in agriculture. As a rule, farmers are nominated for participation in training programmes via the district offices of the agriculture administration, with the desired main areas of training being specified. In addition, farmers and owners of private repair workshops have the opportunity to enroll directly for courses.

The on-the-job training carried out here enables the Training Center, which is involved only in informal training, to obtain the desired number of participants for training programmes with an effective link with the production and advisory sectors at the same time.

A detailed training outline was drawn up jointly by the project and the Ministry of Agriculture to meet both the most immediate and the longer-term training requirements of skilled agricultural workers, workshop personnel and farmers. It takes into account all mechanization methods and maintenance, servicing and utilization areas of importance for the country, together with all aspects of repairing agricultural machinery and workshop organization. The economic problems of mechanization are also given consideration to a limited extent. The training offered is divided into basic and advanced courses. Suitable persons thus have the opportunity to obtain the qualifications needed in a particular job by means of a series of courses attended on a long-term basis.

In principle, the main area of project work is the training of multiplers or "key figures". In addition, the project is endeavouring, within the limits of its possibilities, to meet the requirements of the local sponsoring body as regards training of farmers. This became particularly necessary following official hand-over of tractors to private farmers.

In the advisory sector the project activities are centred on the agricultural institutions run by the state or in other words, the agricultural training and upgrading centres, both formal and informel, and the repair and training workshops. The chosen approach makes it possible to stimulate and advise institutions and define their terms

of referance in such a way that they support and complement the project in its own training work and contribute towards achieving the necessary multiplication effects in advisory and instruction work. At the same time a guarantee is achieved that agricultural engineering matters will be given consideration in teaching and advisory work at the various levels and in the individual institutions within a binding framework, with rational use of resources and avoidance of duplication and overlapping.

In Morocco the Agricultural School (Ecole d'Adjoints Techniques de Mechanique) at Sidi Bouknadel is fully integrated into the existing system of formal agricultural training, a similar situation to that in Thailand. The body responsible for the project is the Department of Vocational Training at the Ministry of Agriculture, which also has jurisdiction over all other agricultural training centres.

Although the project thus has the right institutional basis, seen from a formal technical point of view, its potential scope of action and effect are severely limited. The restrictions take the form of rigid training and admission guidelines, inadequate preparatory training of those completing courses, a heavy emphasis on general subjects and too short a training period.

In the light of the project's task of training technicians to handle the practical use of agricultural machinery and in particular the repair services, there is too little practical training in the two years of instruction. There is not enough time to impart the skills required by an "Adjoint Technique de la Mechanique Agricole", particularly in the light of the stringent requirements placed on the skilled workers for the state machinery services, at whom the training is aimed. Even follow-up supervision of former students at their place of assignment by an expert with a travelling workshop could bring about little improvement in the situation.

In order to utilize fully the available capacity, the school additionally organizes, to a small extent, upgrading of specialized advisory service personnel in the form of short courses in agricultural engineering.

In Turkey the Centre for Advisory Services and Media Production at Söke, like the other agricultural training institutions at the lower and intermediate levels, is under the control of the Directorate-General for Agriculture – Training Division – of the Ministry of Agriculture and is fully integrated into the agricultural training system. Despite the consequent obligation to follow existing training guidelines and standards, the Centre occupies a special position. It is subject to the usual organizational and material constraints only as regards its functions, which cover the area of formal training (providing the training in agricultural engineering at an agricultural college); it is given a largely free hand in its activities, which mainly comprise short courses aimed at upgrading skilled personnel and teachers of agriculture. The links with the Ministry are of importance only insofar as the latter influences the decision on the urgency of training measures and their general theme, the participants and the order of the courses. The Centre itself can determine the form, actual subject matter, length and approach for the courses.

A change occurred following the start in 1978 of a four-year training course for agricultural engineering technicians at the School of Agricultural Engineering set up at the project location, since this meant that formal training gained in importance within agricultural engineering training as a whole.

Within the scope of its terms of reference the Centre at Söke imparts, on the one hand, in the form of standard school instruction, the agricultural engineering knowledge required by the students in their subsequent jobs; on the other hand, it trains agricultural personnel from authorities and schools falling within the province of the Ministry of Agriculture in the expectation that those undergoing training will later pass on their knowledge on a broad basis either to students at schools of agriculture or to farmers. Irrigated agriculture is given particular consideration in accordance with the emphasis placed on it in the region. Worthy of mention is also the fact that the Centre is endeavouring to harmonize agricultural engineering courses throughout the country and to this end is producing suitable training documentation, using as a basis the work sheets issued by the DEULA (German Centre for Agricultural Engineering) and the training documentation drawn up within the project itself.

Follow-up supervision of the above-mentioned course participants employed by the state also takes place in Turkey with the aid of a mobile classroom, which helps to support the former students as they hold agricultural engineering courses for farmers and within schools.

3.2.3 Equipment, input of resources, provision and use of counterparts

In addition to a training programme covering the country's mechanization problems and correct administrative integration, the following criteria are important preconditions for the long-term success of agricultural engineering training projects:

- choice of a suitable location which takes into account the planned catchment area,
- suitable buildings,
- proper equipping with technical and teaching aids,
- availability of suitable land for practical exercises,
- creation of preconditions for continuous operation of the project through the provision of adequate funds by both the donor and recipient countries,
- provision of an adequate number of qualified counterparts,
- attractive salary structure for the training personnel and opportunities for recruiting good-quality specialized staff.

In the projects investigated the situation as regards the above-mentioned criteria and conditions was as follows:

The project location was chosen in each case with particular consideration of the recipient country's financial and administrative possibilities, i.e. use was made of areas

and localities which appeared particularly suitable for the end in view and where the planned projects could be realized relatively easily.

The inevitable consequence of this was that in Sri Lanka and Turkey, for example, the fact that the project was located relatively far away from the local administration caused certain problems in its implementation. In addition, establishment of the project at a less attractive location somewhere in the provinces also had a detrimental effect on the project's ability to obtain and hold on to good-quality skilled local personnel, since these often declined to work on a project in such a location. However, this was contrasted by considerable advantages as regards closeness to areas related to the project, i.e. the relation to agricultural practice and its problems and thus to the target groups in question. In Thailand and Morocco the situation is precisely the other way round: the proximity to the capital created good links with the central administration, while greater effort was required to create links with practical agriculture. In no case, however, did the location create problems which could have placed implementation of the project in serious doubt.

All the agricultural engineering centres have an adequate and appropriate number of buildings at their disposal. Provision of the necessary building land and buildings by the recipient country did not create problems anywhere and, apart from insignificant shortcomings, the buildings have been constructed in such a way that they are fully suitable for their intended purpose. The project agreements provided for financing of the construction measures by the recipient countries. In Sri Lanka, however, where it was impossible to meet the commitments on account of the strained financial situation, the use of available counterpart funds was necessary. It was not possible in every case to commence — let alone complete — the construction work before the start of the actual project.

A considerably worse situation was encountered in the initial phase of the projects as regards audiovisual teaching aids such as transparencies and work sheets, together with subject matter and course content. This documentation, which is so essential for guaranteeing instructive and standardized training, had to be primarily produced by the German personnel — a time-consuming task — or available documentation had to be revised to meet the requirements of the respective projects. The agricultural engineering centres investigated are today relatively well equipped with models and demonstration material.

All four projects investigated have at their disposal areas which can be used for practical exercises to meet various training requirements. Some of them take the form of more or less extensive cultivation areas and in Sri Lanka and Turkey they are actual farms. These farms are regarded by the government as a means of reducing the amount of public budget funds spent on the agricultural engineering schools. Under such conditions the degree to which it is possible to avoid detrimental effects on training as a result of economy measures depends on the skill and organizational ability of the people running the school. In both cases, however, it has so far been possible to avoid such effects. The projects in Thailand and Morocco have only areas for practical exercises and can, if need be, carry out the necessary practical field work on neighbouring private land.

Experience has shown that agricultural engineering projects are extremely well-equipped with agricultural machinery and vehicles. In the projects investigated the available equipment for practical work corresponds to the jobs which are actually performed and can thus be used on a job- and structure-related basis. By dispensing with the supply conditions it was possible to eliminate conflicts of aims which had originally arisen between the tasks and targets of the agricultural engineering projects and the country's specific conditions and structures on one side and the donor country's manner of supplying equipment on the other. In this way the projects were able to procure training equipment corresponding fully to the special requirements and agricultural structure of the respective countries. This proved to be particularly important and advantageous for the organization of situation-related training.

As can be seen in Table 6 on page 57, considerable financial and personnel resources were used in the individual projects.

The input of funds by the donor country for implementation of the projects, as laid down in the project agreements, was adequate for financing the planned measures and equipment. Only a few isolated bottlenecks occurred in Morocco, Turkey and Thailand. In Sri Lanka, on the other hand, provision of equipment and spare parts procured within the country itself was at times impossible on account of an initial lack of funds from the local body responsible for the project and continuous delivery problems. The organization and carrying-out of training in Sri Lanka were, therefore, considerably hampered and still are today.

Apart from the situation in Sri Lanka, the provision of funds to finance the project's running costs, for which the recipient countries were and are responsible as laid down in the project agreements, caused no problems. Due to a lack of state funds, however, training could only be maintained in Sri Lanka in the initial phase by means of recourse to counterpart funds. The regular budgetary funds for the agricultural engineering training centre were increased only gradually to the necessary amount; the same applies to the provision of permanent personnel posts at various levels.

Various difficulties occurred in the individual countries as regards the provision of counterparts. In general, it may be stated that except in Turkey, the provision of counterparts qualified from a technical and teaching point of view was inadequate, particularly as far as their practical skills were concerned. In Turkey, however, there was a better initial situation as regards qualified counterparts, since personnel or former students from the Turkish-German Agricultural Engineering Centre in Gökhöyük, which had already been handed over, were available for the present project in Söke.

When selecting counterparts in Sri Lanka, the qualification level had to be lowered several times in order to be able to recruit the necessary number of local personnel as laid down in the project agreement. It was not possible to obtain senior staff with the required area of specialization and qualifications. The situation in Thailand was similar but less serious.

Table 6: **Input of funds and personnel in the projects investigated** (figures given in DM)

Contributions	Thailand (1967–1976)			Sri Lanka (1971–1976)			Morocco (1970–1976)			Turkey (1975–1976)		
	Thai	German	Total	Singalese	German	Total	Moroccan	German	Total	Turkish	German	Total
Investments and non-personnel costs	1,264,300	806,650	2,070,950	1,191,160	1,907,500	3,098,660	*) no precise details available	1,297,423		662,650	812,000	1,474,650
Personnel costs	160,500	2,348,430	2,508,930	298,200	2,059,600	2,357,800		2,228,475		360,000	525,000	885,000
Running costs	937,450	406,550	1,344,000	205,230	21,000	226,230		10,000		120,000	158,000	278,000
Total expenditure	2,362,250	3,561,630	5,923,880	1,694,590	3,988,100	5,682,690		3,535,898		1,142,650	1,495,000	2,637,650
Number of German instructors	1969–1974: 7 1974–1976: 5			1971–1974: 6 1974–1976: 9			1970–1974: 5 1975–1976: 4			1975–1976: 3		
Number of local instructors	1969–1974: 20 1974–1976: 16			1971–1974: 10 1974–1976: 21			1970–1974: 10 1974–1976: 10			1975–1976: 14		

The unsatisfactory counterpart situation necessitated in both cases selective and extensive on-the-job training of counterparts which placed a heavy burden on the German personnel and meant that they were largely unavailable for other work. Lastly, this shortcoming reduced the overall efficiency of the training during the initial phase and is reflected in the fact, among other things, that the projects must now last for up to ten years, a situation which was not foreseeable. By means of intensive specialized training of the local instructors – in some cases also in the Federal Republic of Germany and with inclusion of teacher training – it has at last been possible to produce qualified personnel for both projects.

In Morocco the lack of financial incentives in particular caused a number of problems in recruiting qualified local personnel and it was necessary in the long run to fall back on former students of the agricultural engineering training centre itself. The turnover of local staff is particularly high for the same reason. At the centres in Turkey and Thailand, and particularly in Sri Lanka, the danger of losing staff is less great, because it was in each case possible to achieve from the very beginning a relatively good salary level for the local project personnel and to ensure that the counterparts had stronger contractual links with the project in conjunction, with additional training in the Federal Republic of Germany.

Viewing the situation as a whole, it may be noted that problems arose in the supply of counterparts for all projects. Obviously a number of measures are necessary in order to provide a satisfactory solution to this problem which is of fundamental importance for implementation of a successful project in the field of training. A project is robbed of one of its most important bases for success if it is impossible to find suitable counterparts, train them during the first half of the project and then retain them as project personnel. If these preconditions are met, however, it is important that – as in the case of the projects in question – the counterparts should be guided up to a point where they can perform their tasks independently. However, the German experts were repeatedly confronted with the problem of whether it is better in the long term to exercise greater influence by assisting the counterparts or to allow them more independence and accept shortcomings. In this respect some of the projects were subject for too long to a high degree of German influence.

3.3 Achievements of the projects investigated

On account of the considerable difficulties generally faced when an attempt is made to assess benefit in monetary terms in the fields of training and advisory work, particularly in the case of achievements at a wide variety of levels and possibly with variations in quality and under contrasting political conditions, the account of the benefits produced by the projects in question will be limited to recording the training and advisory achievements in terms of figures. However, problems occur even if this simple method is used, particularly when comparing training achievements. It is urgently recommended that reports on project achievements be systematized like those on project costs and be made more easily comprehensible.

3.3.1 Direct training achievements

The projects investigated were devoted predominantly or almost exclusively to training and this area of their achievements is, therefore, of particular importance. It should be noted that all these projects had a double training function. On one hand they were intended to train instructors – in other words they had a direct training function – and on the other hand performed an indirect function in that they created the preconditions for extended training in the future (training investments), preconditions which comprise training personnel, facilities and teaching material. When training achievements are assessed a mistake is often made in that only the project's direct (short-term) training achievements are given most attention, although the indirect achievements, seen in the long term, will as a rule be of greater significance on account of the duration and scope of their potential effect.

In general, two groups of trainees can be distinguished in the case of the direct training achievements. These are on the one hand the trainees who themselves make direct use of what they have learnt, so-called "final target groups", such as farmers, tractor drivers, mechanics, workshop personnel and the employees of service and planning agencies and the like and, on the other hand, trainees who pass on their knowlede to others; they may be teachers and advisors or farmer foremen, pilot farmers etc., or, in other words, socalled multipliers.

In three of the projects investigated both types of trainees were calssified as target groups. This necessitated broad variety in the course programme as regards level, approach and area of specializiation, which did not make the work any easier but probably catered for immediate needs. In Sri Lanka, for example, a programme was developed comprising 30 various basic, advanced and special courses. In Thailand and Turkey there was less variation.

In Morocco the situation in this area was extremely simple. The project activities were limited to the training of agricultural engineers (Adjoint Technique de Mechanique Agricole) within the formal training system, with the aim of subsequently employing them as the heads of workshops and machinery pools in the state rural development stations (CMV and CT).

Table 7 (p. 61) shows the direct training achievements on the basis of the number of participants, roughly broken down according to level, function and orientation. It is easy to see that training for workshop jobs was held only at the school in Sidi Bouknadel (Morocco) and, with basic and advanced courses, in Anuradhapura (Sri Lanka).

In general, the main emphasis was placed on training in the use and maintenance of 2-wheeled and 4-wheeled tractors and the most important agricultural machinery such as water pumps, field sprayers and other machinery.

It would be wrong to assess the figures given on to the basis of size; it is more important to decide what effect the training may be assumed – on the basis of the number of trainees – to have had, in the sense of the project objectives. The question of the

scope of the effect plays a major role here, since all the projects in question have a predominantly national approach.

The situation in Morocco is the easiest to assess. Around 250 students successfully completing training, who committed themselves to work for appropriate state institutions for at least eight years after the end of training, could have brought about a perceptible improvement in the workshop sphere. However, there was no evidence whatsoever of this.

In Thailand the students were not committed to putting their specialized agricultural engineering knowledge into practice as soon as possible. The effect of the training which they received had almost no immediate detectable value for practical agriculture. The courses with 331 "final consumers" were undoubtedly useful for those participating, but had a negligible effect in a country with several million farmers. The initial steps in the second continuation phase, however, give promise of far greater success.

In Sri Lanka, which had by comparison the largest project staff (cf. Tabel 6, p. 00), the direct training achievements were considerable, particularly since around 40% of the participants were multipliers or potential multipliers (students). In view of the fact that at the same time the planned economy means that the knowledge gained by the students will be applied in practice by appointing them to appropriate posts, it is highly likely that the project's direct training achievements have already had considerable effects and significance for the country.

In order to assess the situation in Turkey the training achievements of the two agricultural engineering training centres set up so far (Gökhöyhük and Söke) must be included, since they are closely interlinked and are based upon each other. On the basis of the Turkish agricultural administration system, the idea of giving preference to training teachers of agriculture and agricultural advisors – who are subsequently intended to train the "final consumers" in the individual districts – by means of six-month courses on agricultural machinery was an outstanding concept with a broad effect. In this way it was possible, at least to a small extent, to keep pace, as regards advisory services, with the rapidly-advancing mechanization (increase in tractors). In comparison with this the training of "final target groups" – local farmers and tractor drivers – was of little significance.

This concept was continued at the second training centre (Söke). Emphasis was placed in particular on holding refresher and upgrading courses for the "first-generation" students who had successfully completed training. In the future this concept will probably exercise its effect on mechanization of Turkish agriculture in different ways, since an increasing number of the activities are being included in the formal training programme of the higher agricultural college, whose courses now last for four years, and whose students are still very young. In particular, a promotion effect in the sense of a project achievement will not be possible for several years.

Table 7: **Direct training achievements of the projects investigated**
(Number of course participants)

	Thailand	Sri Lanka	Morocco	Turkey
Period:	1969–76	1971–77 (1st half)	1971–77	1974–77
Formal training	158 students on 1-year course as specialized section of the Agricultural College	None	250 students on 2-year course to become technicians (Adj. Tech. de Mec. Agr.)	241 students on 2- and 3-year courses to become agricultural engineers (undergraduate)
Informal training a) Use and maintenace	331 persons on 14 courses of varying lengt and orientation (tractor drivers, machinery operators, farmers etc)	In all 4439 persons comprising a) 3730 persons b) 628 persons and 81 persons on specialized courses Course lengt: 1–4 weeks. These participants included: a) 1877 farmers and young people 360 agricultural instructors and advisors 1337 students	a) None	Altogether 165 persones on spezialized courses, courses lasting 2-6 weeks. The participants comprised: a) 17 teachers of agricultural engineering b) 63 agricultural advisors c) 7 students d) 78 farmers and young people
b) Workshop activities (repairs)		b) 105 farmers and machine operators 279 mechanics 117 agricultural and agricultural engineering instructors and advisors 35 agricultural machinery dealers 21 students	b) Short courses for food technology engineering students (number of participants not known)	
Remarks:	In 2nd phase: 1.6-30.11.1977: under a) 12 courses, 454 persons, including 220 pilot farmers and foremen 165 credit advisors 72 teachers of agricultural engineering			In the Gökhöyük preliminary project: between 1969 and 1974: 180 advisors and teachers of agricultural engineering trained in 6-month courses; they then progress to instruct farmers and tractor drivers at district level (e.g. Afyon, 1973: 180 farmers and Denizli: 133 farmers)

Although, as stated elsewhere, good, formal agricultural engineering training is essential in the longer term, the question nevertheless arises as to whether, in view of the mechanization of Turkish agriculture, which is expanding by leaps and bounds, this has already been done to an extent adequate for meeting the immense present need for agricultural engineering training.

3.3.2 Indirect training achievements

As already indicated, indirect training achievements can be made in three fields:

1) training of instructors,
2) creation of facilities and
3) production of training material.

All three components are highly important for successful training in agricultural engineering; the first-mentioned aspect is in any case a "conditio sine qua non".

However, even the most capable instructor soon reaches the limit of his opportunities if the other two components are missing. All three were consequently included in the concept of all the projects investigated.

Varying achievements were accomplished as regards the training of instructors, depending on the size of the project, i.e. the scope of the project framework laid down. In Thailand eight skilled workers were trained to become agricultural engineering teachers, who are now able to take over the agricultural engineering instruction planned within the scope of the project, both at the AETC itself and on external courses. These teachers received their fundamental training on twelfe-month DEULA courses in the Federal Republic of Germany. One of the major tasks of the German experts working on the project was then to guide them until they could put over their knowledge in the form of instruction.

In Sri Lanka greater emphasis was placed on on-the-job training for the trainee teachers. Here too, however, 24 skilled workers underwent a six-month period of specialized agricultural engineering training in the Federal Republic of Germany; in order to save time, the training was given in English. The level of training achieved in this way appeared adequate for the first stage of technical development and was a rapid means of obtaining teachers who were able to an increasing degree to take over the actual training work.

A procedure similar to that used in Thailand was employed for the projects in Morocco and Turkey. Eleven agricultural engineering teachers (at the 1st level) were trained for Morocco and 30 for Turkey by means of twelve-month courses in the Federal Republic of Germany, followed by guidance enabling them to take over gradually the teaching work, and to supplement their knowledge and back it up with experience. However, whereas in Turkey a relatively large staff of adequately qualified agricultural engineering teachers has gradually become available, not least as a result of the first agricultural engineering project in Gökhöyük, the desired and necessary

number of counterparts was not achieved in Morocco by the end of the project, a situation which has placed the standard of the subsequent training at the school in great jeopardy.

On the whole, the training achievements as regards the agricultural engineering instructors may be assessed as excellent, at least in Thailand, Sri Lanka and Turkey; these teachers still have 30 or more years of working life before them and in the course of their work can achieve far more in the way of training than can a project team in the limited time at its disposal, even under optimum conditions.

All four projects must be assessed in a similarly favourable manner as far as the creation of training institutes is concerned:

The well-organized and appropriately-equipped training centres created in an exemplary manner in these countries in the course of the projects have been supported to varying degrees by the project partners as regards equipment and financing, but the agricultural engineering knowledge of the experts has in each case been used in a decisive capacity to ensure the appropriateness of these facilities and has thus become, in the true sense of the word, a decisive component for the effectiveness of the investment.

The investment of time and funds in the teaching materials is of equal importance. The teaching materials and equipment included in the project expenditure can in most cases provide only a small proportion of what is actually needed; of greater importance are the documentation and material produced in cooperation with the future national instructors at the training centres and which, when used in the training programme, represent a contribution by the project which will continue long after the actual project has been handed over.

In the projects investigated the great importance of this third component of the indirect achievements of a training project was not fully recognized everywhere or given the necessary priority. This work should have been made a primary concern at the latest when the "first generation" of teachers returned to the project following training abroad. Situations would not then have resulted in which important courses have not yet been appropriately prepared a few month before the end of the project.

On every project the experts must first of all amass the necessary experience and adapt the available documentation to the prevailing conditions (as regards language and content), tasks which require a great deal of special knowledge and time. In order to make this work easier plans should, therefore, be made to intensify in future the exchange of the documentation produced and experience gained in the various training projects; this could best be done via a central processing office. In the case of all four projects in question it was possible to draw up important documentation for the various courses and programmes, some of which is already being used and highly regarded in the country concerned outside the project itself. This success, however, was achieved only with great expenditure.

In conclusion it must be said that the projects have accomplished considerable indirect effects in the training of instructors and advisors and in the provision of training facilities and back-up material. These achievements must be considered as being at least just as valuable as the projects' direct training achievements, since they represent in each case considerable potential resources for future training.

3.3.3 Advisory achievements

The objectives of all the projects investigated contained an advisory component as well as the training component. Essentially, the projects were to advise the ministries and their competent departments and administrations on the setting-up and equipping of similar institutions, the design of training programmes and, in the technical field, the setting-up of workshops and spare part services. Only in Morocco was it intended that the advisory services should not play a major role; instead, it was planned that there should be follow-up supervision of the former students from the agricultural engineering school at their places of assignment.

On the basis of the working reports it can be assumed that numerous advisory sessions of this type took place, less in the shape of formal consultation than in the form of discussions and in particular visits to the project facilities. Only in Sri Lanka did the training centre in Anuradhapura have the express task of assisting in a planning and advisory capacity in the setting-up of five teaching and farm workshops and aiding in the improvement of the agricultural engineering training and advisory service. In addition, farms and institutions were also given advisory assistance in the procurement of machinery and other problems of mechanization.

Seen as a whole, the projects' advisory work remained in a position of secondary importance, not least because there was no corresponding demand on the part of potential enquirers.

In this context there arises the fundamental question as to whether our customary linking of vocational training and technical advisory services is appropriate in developing countries. On the basis of the results described above, the structures of most countries make it advisable that there should be a clear decision at the start of the project as to what is to be promoted: the formal vocational training system or persons already engaged in their profession. If it is the latter, measures should comprise specialized upgrading and aid in solving problems by means of problemoriented courses and linked advisory services. The ways in which this decision should be reflected in the design of the projects will be described later.

4. STRATEGIES FOR PROMOTING AGRICULTURAL MECHANIZATION

Agricultural mechanization is a process which must be set in motion within an ecomonic system in such a way that it is appropriate and situation-related and must be shaped in accordance with a chosen objective. Economic and social aspects must be given equal consideration. Promotion approaches and measures form the constituents of a programme of this type and characterize the strategy for action. The initial situation and the political conditions also have a strong influence on this, as do the operational factors in the agrarian structure, the financial situation and production profitability.

4.1 Promotional approaches

Taking into account economic and operational aspects, the overall field of agricultural engineering comprises four areas (cf. Section 2.1, p. 15). Development policy measures may accordingly be implemented in the following areas:

- creation of suitable conditions for use (land development) and improvement of the infrastructure (road construction, electrification etc.),
- development (design) of new or adapted technical equipment and structures (technical development),
- production and maintenance of already developed technical equipment (manufacture and workshop activities),
- introduction and use of the technical equipment (operation, maintenance and training) and
- optimum selection and organization of the use of available techniques and linking of same to technologies (application planning and advisory assistance).

If the above-mentioned promotional approaches are converted into activies which will help to develop agricultural mechanization, we obtain the following four groups of measures:

1) In the field of personnel:

- training of skilled personnel for the technical field of agricultural engineering (for the development, production and repair of machinery and equipment),
- training of skilled personnel for the organizational and operational fields of agricultural engineering (for planning and organization work, together with procurement of equipment and advice on its use),
- training of instructors (teachers of agricultural engineering) to provide instruction on the use of machinery and appliances,
- training of the users and operators of the technical equipment at all farms and institutions where it is used (farmers, farmers' sons, tractor drivers, machine mechanics).

2) In the field of equipment and facilities:

- land development with a view to suitable conditions for use of machinery, adequate transport routes and energy supplies,
- setting-up of development and testing institutions in the field of agricultural engineering,
- provision of suitable (tested and adapted) technical equipment (including energy sources) by means of domestic production or imports and
- setting-up of an appropriate spare part and repair service network.

3) In the economic field:

- exercising influence on the supply prices of the technical equipment,
- exercising influence on the prices of important agricultural products and thus on the financing power of the farms and,
- financial measures, particularly subsidies and low-interest loans to finance the purchase of equipment.

4) In the organizational and legal field:

- setting-up of state-run public undertakings (machinery services),
- setting-up of machinery cooperatives,
- determination of land cultivation rights (private property, producers' cooperatives, collective farms, state farms).

It ist probably impossible in any developing country to design the four groups of measures virtually from scratch. Even in the least developed countries there is a certain amount of "basic capital" in the individual areas. It is, therefore, fundamentally necessary to design the promotion measures on the basis of the prevailing conditions. The need to implement individual measures is thereby determined essentially by the situation and level of development in the country concerned. The following questions could be used to analyse the situation in the country:

- What are the "guidelines" for situation-related mechanization of agriculture given the prevailing political aims of the country in question and to what degree does the state wish to exercise an active influence in the individual areas (high degree of economic control and intervention or a more liberal attitude)?
- To what degree are preconditions – as a whole or in part – for development of agricultural mechanization through the country's own efforts already in existence and how would it be possible to create suitable preconditions related to the agrarian structure? Are already extensive rural development programmes or other structural alterations in progress or necessary?
- What institutions are required and should be created, if necessary, in order to ensure that the necessary mechanization measures have an effect, taking into consideration socioeconomic aspects?

- What is the personnel situation in the field of agricultural engineering training and advisory services? In particular, what skilled training and advisory personnel and what training facilities (course etc.) are already available?
- What personnel requirements over what period of time are to be expected during the mechanization process in the fields of development, production, services, training and advisory work?
- By what means can development of agricultural mechanization best be achieved (supply of machines by means of national production, free imports, tariff preferences, quotas etc.) and how must the marketing, spare part and workshop systems be built up accordingly?
- In what ways can the acquisition of agricultural engineering equipment be made easier (loans, subsidies) and what organizational units should be primarily promoted (e.g. single farms, cooperatives, state farms)?
- How important is the use of machinery above singlefarm level (machinery cooperatives, machinery syndicates, machine contractors, state services etc.) and how can this be promoted in order to minimize investment if possible and to optimize the efficiency of the machinery resources and thus that of the capital input?

When answering these questions particular attention should be given to determining what starting points for effective promotion of the mechanization process in the desired direction are already in existence, what resources and time will be required to achieve a particular goal and what likelihood there is that this goal will be reached. The final result will produce a national mechanization programme, which is an essential basis for a national policy.

A national mechanization strategy of this type becomes particularly important when a decision is to be made on the measures for which assistance must be obtained from outside in the shape of personnel and finance, for aid of this type can have a permanent effect only if it is correctly geared to the country's condition and measures.

The countries providing assistance are, therefore, faced with the question of which tasks they can take over in a national development plan and how, and at what level, they can most suitably implement external aid measures. In principle, external assistance is all the more effective the more it helps to overcome bottlenecks (principle of the minimum factor) and the greater the internal development efforts made by the country in question in the relevant field. However, with a view to the institutional integration of measures and the way in which the various tasks are to be performed, the following three factors must be taken into consideration:

- the limited amount of funds available: as a rule, external assistance covers only a fraction of the total funds required to implement effective measures,
- the limited amount of time available: the time period required for a measure to have its full effect on the target groups is longer than the duration of most projects and

- the limited nature of the opportunities for external influence: without energetic commitment by an adequate number of good-quality personnel from the country in question the continuity of the measures and, in the long run, the certainty of achieving the target, cannot be guaranteed.

This indicates that promotion programmes aimed at economic development can be justified only in places where the conditions guarantee adequately secure "integration" of the external assistance offered and supplied. In the case of measures in the field of agricultural engineering and mechanization, this means that there is a need for a national mechanization plan. A basic plan for mechanization should in itself be a fundamental component of a country's overall agricultural development plan.

4.2 Special status of training and advisory projects in the field of agricultural engineering

In developed countries improvement of vocational training is primarily the task of the general educational system. This comprises the various levels of specialized training with corresponding diplomas and certificates, which entitle the holder to exercise a profession at a corresponding level. Informal training programmes are an accompaniment to this and are used for special preparation for jobs, upgrading measures and a variety of other purposes. The setting-up and development of an efficient vocational training system is a lengthy and expensive process and can be regarded as a measure of the degree to which a state has developed into an industrialized nation.

In view of the fact that vocational training, when part of the general educational system, is extremely formal and is mostly subject to strict state guidelines as regards length and content, it may be described, to simplify matters, as formal training. In contrast, the courses, seminars etc. with a flexible form, content and length can be termed informal training. The main feature of the latter is that they are directly oriented towards a particular job; they can also be easily adapted to developments in the economy, technology and knowledge. They can of course also lead to certificates and, if systematically built up, may by all means result in complete training programmes.

In the course of German Technical Cooperation with developing countries the question thus arises as to which form of training should be given higher priority in particular situations.

Formal and informal training programmes differ considerably as regards the promotional effect. They therefore occupy different positions within promotion strategies.

Promotion activities in the field of formal training, particularly if they come from outside, must be considered essentially from the following angles:

- All activities are integrated into the usually extremely rigid training guidelines in existence everywhere. These guidelines decisively determine the length, form and content of the training. This frequently results in the training programmes (even at university level) suffering from an excess of general subjects.
- Formal training, irrespective of level, provides only general preparation for a job but does not qualify students for the job. This is usually not done until later through an "apprenticeship".
- The cost of formal training is, as a rule, borne by the general public. Students are admitted to formal training institutions in all cases on the basis of examination results or similar criteria. There is no guarantee that the knowledge which they acquire can subsequently be used, particularly if the departments responsible for the training programme are not those responsible for subsequent employment of the students.
- In view of the fact that the cost of the training does not play a part, there is usually a large number of applicants for the technical training centres in particular, so that these institutions are used to their full capacity.
- Once students have completed sections of training within the formal training system they are entitled to a certificate giving the level of qualification which they have attained. Possession of a certificate facilitates entry into a job.
- Formal training programmes mostly last for several years, so that it may be sometime before the knowledge acquired can be used.

Promotion activities in the field of informal training, particularly in the form of short courses and one-day programmes, are somewhat different:

- They involve, in principle, job-related training.
- The training can (and will) be directed mainly at people already at work or shortly to start work and the knowledge acquired can thus be used immediately.
- There is no prescribed framework regarding the nature, length and content of the training programmes. In principle the programmes can be fully oriented towards a particular target and possibly also chosen so that they are optimally geared to their location.
- In view of the fact that most of the courses are relatively short it is possible to cater for a far greater number of people than can be done by means of formal training programmes, with a comparable use of resources.
- Unless courses of this type can be offered free of charge as part of special training programmes, the question of who pays for the courses plays an important part. If the participants have to pay all or part of the cost themselves this may have an inhibiting effect on attendance.
- In view of the fact that the training programmes are predominantly aimed at people already engaged in their profession, an additional problem is deciding on the right time of the year to hold them. Together with the cost problem the problem of full utilization of personnel and facilities throughout the year then

also occurs. In most cases it can be solved only by combining informal training programmes with formal training or with advisory work.

– On the basis of the determining criteria mentioned above, special courses lasting several months and longer training programmes for agricultural engineering teachers and other specialized senior personnel – if they are not held within the framework of general training guidelines – must be included with informal training and are particularly important as a component of "institution building".

If the advantages and disadvantages of the two training programmes are weighed against each other informal programmes appear particularly suitable wherever a large number of people already at work are to be reached within a short period and with comparatively few resources. The course participants can thus gain specialized basic knowlede and/or additional knowledge on innovations relatively quickly and in this way put it into practice within a short time. This is applicable to the initial phase of agricultural engineering development in many countries. The formal training programmes to be set up alongside this must be regarded on a longer-term basis and continue over a number of years. They form – at least in the case of the advanced colleges – the basis for allowing the country to carry out on its own the training required in the future in the relevant area. These formal training programmes must produce the country's own qualified personnel for the various spheres of activity. This requires time and cannot create a widespread effect, at any rate not during the initial mechanization phase.

If the target in agricultural engineering advisory services is to be creation of a widespread effect, to be produced by an adequate number of qualified skilled personnel, it is obvious that during an initial stage in mechanization development some of the agricultural advisors should be given additional training in agricultural engineering. They can then act as multipliers and use their special knowledge in the course of advisory and training work. Using appropriately-designed training programmes built up of a number of courses, it is possible in this way to provide a fairly large number of advisors with adequate technical knowledge concerning the use and operation of machinery and planning of its use. They can then pass on this knowledge to the users of the machinery.

Considerably less success can be achieved in this way in the field of workshop activities. Although – if the participant and cost problems have been settled – informal courses can be introduced at the start with a view to a broader effect for the initial phase, great importance must additionally be placed from the outset on formal vocational training to provide qualifications. This formal training must include the necessary practical work as is the case, for example, in the dual vocational training system in the Federal Republic of Germany.

If vocational training for mechanics is already provided in a country in the industrial sector, it is not essential to include overall technical training in an agricultural engineering training institution. Under such conditions it is appropriate to make the basic training part of general mechanical engineering training and to supplement it with agricultural engineering courses. In this way it is possible to bring about considerable reductions in the long start-up periods for technical training programmes and possibly also considerable savings on the cost of equipment and facilities.

To sum up:

– In all countries formal training institutions are the basis for long-term development of general and vocational training. However, if – as is usual in development projects – the achievement of a widespread effect and an early effect on the target group are considered to be of relatively great importance, considerable doubts must be raised – despite all the advantages – as regards the benefit of agricultural engineering development projects in the field of formal training, particularly if, in addition to the delayed effect of the imparting of knowledge, there is a high risk that those receiving such training will not subsequently perform work related to their specialist field. If formal training is nevertheless held as part of a development project, the lastmentioned element at least must be eliminated by means of contractual commitments.

– Informal training programmes and advisory work generally give promise of a faster and greater contribution towards development. This applies particularly in the countries where the mechanization process is already under way. Increased efforts are necessary here to prevent development from taking a wrong turn and to reduce the often extremely high costs of using the machinery (wear, damage etc). Measures with a rapid and widespread effect are essential.

– Seen as a whole, training and advisory work must be developed in the same manner to guarantee effective agricultural mechanization. The function of a national development strategy is to decide to what extent and over what period formal and informal agricultural engineering training, in collaboration with the agricultural advisory services, are to impart the necessary specialized knowledge to the target group in question, so that development in agricultural engineering caters for the needs of the country's agriculture. There can be no doubt as regards the great importance of training and advisory services within the agricultural mechanization process.

4.3 Criteria for assessing the project strategy

In order to assess various approaches for promotion measures – in general and in particular for projects involving external development aid – the following four criteria can be used:

1. **Likelihood of success**, i.e. the probability that definite targets will be reached: the likelihood of success is all the greater

– the nearer to the target group the measure is implemented,

– the more the measure meets the wishes of the target group,

– the more specifically the measure is geared to the prevailing conditions and the target,

— the greater the degree to which the target group is tied to its function, e.g. farmers to their farms, teachers and advisors to the state administration (but no pupils and students in the general education system).

2. **Speed of success**, i.e. the time required for the effects to reach the actual target group. In the case of mechanization this means the period which elapses before the direct effects of the measures can be seen in the sector of agricultural production and processing and the direct effects in the technical manufacturing and services sector and in the social field.

   This period is all the shorter

   — the greater the degree to which the measure is directly implemented in the production sector (in the use of techniques, creation of condtions for use, provision of services) and

   — the greater the amount of resources used.

3. **Scope of success**, i.e. the number of persons and institutions who can be reached within a given period.

   The scope of success is all the greater

   — the more means of multiplication are used (training and advisory services on a group basis, mass media, information material),

   — the higher the level at which a measure is implemented in the hierarchy of a multiplication system,

   — the greater the amount of resources used for a given target.

4. **Project costs**, not in absolute terms, but in relation to the desired effects as regards area covered, time taken and intensity.

The criteria given are in part contradictory; for example, although the multiplication of knowledge over two or three "training generations" produces a widespread effect, it nevertheless reduces the likehood of success and greatly increases the period which elapses until the measures take effect at the lowest level; or the development of an agricultural machine geared to a country's specific conditions may give signs of a high likelihood of success, but as a result of trials, manufacture, introduction etc it may be many years before the target group — in this case the farmers — can derive noticeable benefit.

Different assessments will be reached, particularly as regards the efficiency of the project, depending on which criteria are considered most important. In the assessment of project efficiency a particularly important factor is constituted by the preliminary services and continuous contributions which can be provided by the country being assisted, for we can assume that an external measure will be all the more effective and efficient

— the more it is supported by an efficient partner,

— the greater the competence of the sponsoring institution in creating and establishing the necessary conditions for development and

— the greater the efficiency of the sponsoring institution in propagating know-how and skills.

It would be desirable to view all development projects in an economic light and to optimize the cost-benefit ratio. An economic assessment of this type is possible in principle but causes immense problems in evaluation of output in the case of all training projects.

It therefore seems more practical to apply the cost minimization principle to a given training measure. In order to do this, the number of course participants at agricultural engineering training and advisory centres must first of all be estimated and determined on the basis of the number of skilled agricultural engineering personnel required over a given period. An estimate of this type is based on the GNP forecast and the development of the agricultural sector — broken down into areas — and deduces the necessary areas of emphasis in training for each group of personnel on the basis of the expected distribution of workers within the individual sectors or areas.

In view of the fact that this method has a number of shortcomings, planning of the future need for skilled agricultural engineering workers should be reduced to drawing up a forecast for specific requirements in the field of agricultural engineering skills. The aim should be quantified listing of the types of skills which will most probably be required within a particular period.

Seen from other points of view, an agricultural engineering training and advisory centre is a social investment project for the government concerned. The social benefit is set against the social costs in order to assess the project (it is assumed that training can be placed in relation to the subsequent income of former trainess from agricultural engineering schools). Social profitability calculations are comparable with calculations of personal economic profitability apart from the fact that in the former all resources are included in the cost accounting, whereas in the latter only the costs actually incurred are calculated. Profitability calculations of this type have been drawn up, for example, for the training system in Thailand (M. Blaug, The rate of return on investment in education in Thailand, Bangkok, National Education Council, 1973).

It must, however, be made clear in this context that a social profitability analysis is no better as an assessment criterion for agricultural engineering training centres than calculations of personal economic profitability. It simply appears too difficult to take specified earnings figures as practical indicators of the contribution to production which the former trainee in question will make in future. This means that only an analysis of costs per training place can primarily be used as an economic assessment criterion.

In order to be able to apply criteria for economic dimensions of projects, such criteria must be determined by means of comparisons between alternative forms of training or even between actual training projects. In the limited investigation of four agricultural engineering projects it was not possible to contrast the qualitative and quantitative requirements of the training programmes in such a way that a comparative operational cost analysis would have had informative value for later projects. At best a cost analysis of this type can be used to indicate the size of the average annual expenditure, the proportion to be paid by the partner country and the number of days of training possible with this expenditure.

Even if it is assumed that the cost per training place can be used as an economic criterion in project assessment, an informative outline should be developed first of all — on the basis of the training criteria — from which the economic data can be derived.

Only when the project activities are systematically represented is it possible to determine economic values, assess training alternatives and facilitate international comparisons. The result of this work will also provide a basis for deciding whether a student or counterpart should be trained in the Federal Republic of Germany or in his native country. Lastly, project data of this type can be of decisive importance when preparing hand-over of a project, particularly when deciding what burdens are to be borne by the partner country.

5. RECOMMENDATIONS ON THE DESIGN OF AGRICULTURAL ENGINEERING DEVELOPMENT PROJECTS

It has been indicated by what has been said hitherto that, viewing the situation overall, the following four areas must work together in order to ensure that agricultural mechanization achieves a positive effect in terms of development policy:

1. Agricultural engineering research and testing of equipment in order to develop forms of mechanization appropriate to the location (equipment, machinery, structures),

2. Agricultural engineering industry, together with trade and craft to ensure procurement and maintenance of the necessary appliances and machinery, including auxiliary materials,

3. Agricultural engineering training and advisory services in order to provide the knowledge and information necessary for proper use of the technical aids and

4. Political and administrative measures in order to create suitable legal, organizational and economic conditions for agricultural development in accordance with the development target and integration of mechanization as a major component of this development.

Development projects can be implemented in all four sectors, albeit with different areas of emphasis:

— Agricultural engineering research projects, in some cases coupled with testing facilities, predominantly attached to academic institutions and therefore possibly part of "Educational Cooperation".

— Assistance in the manufacture of agricultural machinery; high capital input necessary, therefore mostly an object of "Financial Cooperation" in the field of industrial promotion, also applicable to workshops within an growth process going beyond the narrow confines of agriculture.

— Concentration of Technical Cooperation in the field of agriculture principally to the areas specified in items 3 and 4 above, and some of those in item 2, but only in countries where promotion of equipment manufacture and repair and spare-part storage facilities for agricultural machinery is a necessary component in the promotion of agricultural development.

The following remarks relate only to Technical Cooperation. As regards the first two areas, it is enough to point out that the development of suitable research and machine testing by the country itself, including the corresponding training opportunities, is of importance in every country, even though priority as regards time and resouces may vary. The same applies — albeit with limitations — to the development of machinery and appliances in factories and workshops within the country itself. The last-

mentioned point is of particular importance because of the need to create jobs and to save foreign exchange which is mostly in short supply.

5.1 Orientation of agricultural engineering development projects towards training, advisory assistance and services

Unless they deal with academic education, material procurement or farm development, Technical Cooperation projects in the field or agricultural engineering must always essentially be training, advisory and service projects. Training and advisory projects are aimed at improving the knowledge and skills of a particular target group by imparting the necessary knowledge and skills, by direct or indirect means, through training and advisory assistance. As a rule the reasoning power of the target group is to be trained and attitudes changed (motivation).

Cooperation projects become service projects when the promotion consists essentially in taking over and correctly performing various tasks. However, following the basic maxim that this type of help must always be help towards self-help, these projects too must include a training element. This is possible either within the service agency itself or within parallel institutions, so that the preconditions for a gradual take-over of the tasks performed initially by outside personnel can be created. This requirement applies to services at all levels and in all fields, i.e. to work at ministries and public institutions and to that of workshops, schools and other training centres already in existance.

The important role played by training in all agricultural engineering development projects should be clearly formulated in the project concepts. This can be done as a rule by taking as the project aim a specific training and advisory achievement (know-how transfer), the duration and extent of which are to be laid down in detail. The same applies to service projects in which correct taking-over of the service (= function) by skilled personnel from the country in question is to be set as a target unless the task in question is one which is to be performed only once and has a limited time horizon.

Successful training and advisory work in agricultural engineering is dependent upon specific personnel, material and organizational preconditions, which, in many developing countries, are no less in need of development. Training and advisory projects — and service projects — can therefore manage very rarely without creating any actual institutions at all. However, it is important that the buildings which constitute these facilities be always regarded only as a means to an end and do not form the major content of the promotional measures — it is always tempting to allow them to do so, since they represent a visible result.

As a rule, the preconditions for promotion must be largely created by the country receiving assistance. Strict criteria must be applied when deciding which structural and technical investments could possibly be taken over by the country providing the aid. It can nevertheless be practical for the latter to take over some of the investments, at least in part, since this would mean an earlier start to work, higher quality and a more widespread effect for the promotion efforts, exemplary design of facilities and a guarantee of the work opportunities for the personnel assigned.

Such investments should, in principle, be considered from the point of view of "institution building". If we ignore pure service projects, which perform for only a temporary period functions for which the partner country does not yet have suitable personnel, "institution building" is always a major element of the project's tasks; this means that in view of the limited duration of the project intense efforts must be made from the beginning to set up or expand an institution which is able to perform satisfactorily the functions which it assumes following completion of the project.

In addition to the buildings and technical facilities, training of qualified personnel is an important component of this "institution building". As a rule, the counterparts must first of all undergo a special training programme and subsequently be allowed a period of practical experience during which they are advised and assisted by the experts.

The long-term benefit of a training and advisory project depends for the most part on how far this training can be successfully carried out. The skill of the foreign experts and any other achievements which they may accomplish cannot compensate for shortcomings in this sphere of activity.

5.2 Importance of training scholarships abroad

In conjunction with the training of native personnel, the training of senior supervisory personnel from the recipient countries is assigned great importance for the following reasons:

1. As a rule, training abroad leads the trainees to perform practical work which they could not carry out in their native country for fear of "losing face".

2. Work and training within an economic and social system which is comparatively heavily oriented towards accuracy, reliability and achievement creates understanding for these major factors of a successful economy and leads the trainees, at least in part to assume this attitude and transfer it to their sphere of operation in their native country.

3. A stay abroad increases overall thinking capacity, aids critical analysis of problems and the finding of solutions.

4. A stay abroad has prestige value and promotes the development of potential leaders with corresponding motivation.

In as far as agricultural engineering training and advisory projects require high-level personnel who are subsequently intended to act as influential multipliers at national

or regional level, training periods abroad lasting several months can be regarded as an actually effective means of developing technical skills and personality. This applies to agricultural engineering to a greater extent than other fields of production engineering, since here the basic principles and systems of mechanization (combustion engines, electricity, field-working machines, harvesting machinery etc.) demonstrate a high degree of standardization and the transfer of experiences is therefore possible.

Despite these positive features, the following important counterarguments must not be ignored:

- Training abroad is relatively expensive.
- If the courses are held in the Federal Republic of Germany a language problem arises; if the training takes place in a developing country where the trainees' own language is spoken the positive effects – personality development and acquisition of prestige – may not occur.
- Lengthy absence by the chosen counterparts from their native country may have an alienation effect.
- If the chosen counterparts are abroad during the initial phase of the project, problems occur; substitutes must be found and the trainees have to be fitted into influential positions once their training abroad is over.
- Lastly, the certificates gained abroad may not be recognized in the developing country or cannot be properly classified.

These disadvantages can be countered, at least in part, if the training takes place according to foreign-language groups and comprises individual sections of reasonable length and special programmes tailored to the jobs to be subsequently taken up by the trainees. The scholarships should, moreover, be limited to training senior personnel within the framework of "institution building" (cf. Section 5.1 p. 76). In this case the high cost appears justified. In order to solve the personnel problem the first counterparts should undergo their special training as soon as possible after the start of the project. Nevertheless, scholarships for training abroad should in principle be awarded only to personnel who already have an adequate technical background and have clear links with the project.

Moreover, particular emphasis should be placed on the practical, job-related element in the training, since it is in this respect that the greatest problems usually occur in developing countries.

5.3 Problems of capacity utilization and financing of agricultural engineering training projects

The attitude – in principle extremely critical – to the formal training system as a starting point for promotion of agricultural mechanization as part of development projects is confirmed by the experiences in the countries investigated:

Formal training programmes are slow to take effect, it is uncertain whether they will achieve their targets and in many cases they are not adequately geared to dealing with the tasks which occur in practice. Above all, they are usually too general and theoretical, simply because they lead, as a rule, to state examinations which usually entitle successful canditates to go on to further study.

In this respect they are not aimed at preparing students for practical work, at least not directly. In many cases there is also an aversion to practical work and "dirty hands". Consequently, stringent measures are usually the only way of guaranteeing that once they have completed their training the students are available for the planned practical work in agriculture for the number of years for which they have committed themselves.

Experience has shown that additional training abroad may sometimes help to overcome such difficulties. However, we must not exclude the possibility that utilizing the acquired knowledge in the private sector with its good salaries may appear more attractive than a position with a state authority or institution, which usually have only mediocre salary structures.

A major advantage of promoting formal training facilities is, however, the fact that such facilities have as a rule a secure financial backing in the form of a corresponding budget and need have no worries that the facilities will not be appropriately utilized. This applies to an increased extent if the state awards grants which eliminate financial difficulties on the part of the students.

In the case of informal training facilities, similarly high degrees of utilization can be achieved only if the state authorities are generous when awarding subsidies and releasing people for training, for in addition to financial difficulties, training facilities which concentrate mainly on practical agriculture must cope with the problem that the farmers can be spared from their farms during only a few weeks or months.

It is thus obvious that in order to achieve optimum utilization of personnel and institutional capacities in agricultural engineering training projects a formal training course should be combined with informal training and advisory activities. This produces a rounded programme, even if the short-comings of specialized formal training facilities as a means of promoting development in agricultural engineering cannot be eliminated in this way. However, the situation must not go so far that as a result of their state control the formal training programmes restrict the informal training activities too heavily or even largely displace them if resources are in short supply.

In view of the fact that it is extremely difficult to create in any other way an appropriate "package" for an agricultural engineering training and advisory institution – at national or regional level – combined training and advisory projects will have to continue to be implemented in future. Attempts should nevertheless be made as far as possible within development projects to achieve satisfactory utilization of well-equipped informal training centres by means of an adequate range of courses, attractive for a wide variety of interests, perhaps designed along the lines of the DEULA

centres (German Centres for Agricultural Engineering) in the Federal Republic of Germany.

Financing of training institutions if often a difficult question. There must in all cases be insistence that the institution is given sufficient financial support in the government's budget. Provision must also be made for funds to cover the participants' course costs (travelling expenses, board and lodging). Production facilities linked to the institution (farm, workshops etc.) can provide valuable funds to supplement the budget and opportunities for practical work; however, they may also have a burdening and detrimental effect upon the actual training function.

5.4 Level of approach and institutional embodiment of agricultural engineering development projects

The level of the project approach and its institutional embodiment are of major importance for the scope and effect of agricultural engineering promotion measures. In general, projects can be implemented at three levels:

1. National level
2. Regional level
3. Local level.

5.4.1 Projects at national level

Projects at national level have potentially a widespread effect. Their effect as a whole, however, depends primarily on whether there is good communication with (and potentially interested persons at) the lower level and whether major decisions can permeate to this level and be implemented there. In consequence, promotion measures at national level must be examined to check that these preconditions exist. These requirements also include the existence of a logical mechanization programme. If no such programme exists – which is usually the case – the drawing-up of a national agricultural engineering development strategy can in itself be an important "preliminary investment". The work of government advisors or "service providers" in supra-regional institutions, for example, then has corresponding priority. This applies in particular to countries where agricultural engineering has not as yet developed very far and which still offer a wide variety of opportunities for shaping the mechanization process.

In addition to central advisory and planning work, training and advisory facilities can be based at national level and can have effects extending beyond the limits of regional responsibilities (provinces, districts etc.). These will be primarily training and upgrading institutions – such as in-service training centres and training centres for advisors – for skilled personnel with a fairly high level of training, who are either already engaged in their profession or who are being trained for the future. Such facilities are set up in particular to train and upgrade personnel and specialists (senior personnel) in positions of responsibility by means of an appropriate system of courses.

It appears far less practical to set up agricultural engineering colleges – in addition to faculties of agricultural engineering and other scientific research and investigation institutes, which are not under discussion here – as development projects within the formal education system. The benefit of such facilities, assessed on the basis of their effects on the agricultural development of a country in general and mechanization in particular, may not become evident for many years. The success of agricultural engineering institutions within the formal education system is extremely uncertain, since it is almost impossible to guarantee that those trained will be able to obtain an appropriate job. This applies in particular if the formal vocational training system falls within the province of a ministry other than that which covers the former students' professional activities.

It is essential, therefore, to subject the job requirements for subsequent and, to a still greater extent, the possible training programmes, to a critical examination in advance. It is precisely the formal training programmes (school curricula) which often burden the college curricula with an excessive amount of subject matter not related to the specialist field. Too little attention is paid to the fact that the practical instruction determines, to a decisive degree, the extent to which the students are suitable for subsequent employment in the field of agricultural practice. Provision must be made for adequate periods of practical experience both during and possibly also after training. This, however, presupposes

- the existence of suitable institutions for practical training – development of these facilities should, therefore, in any case be given high priority in conjunction with formal training programmes;
- that the other training has its institutional basis in the ministry which is also responsible for practical training and advisory work.

In general, considerable reservations must thus be voiced as regards the promotion of formal training institutions as a Technical Cooperation measure. It still appears most practical to supply specialist teachers, equipped with the necessary teaching material, as a form of service and, parallel to this, to train skilled local personnel on the spot or by means of scholarships for further training so that they may subsequently take over the functions performed in the meantime by external experts.

5.4.2 Projects at regional level

If agricultural engineering development projects are implemented at regional level, it is ensured that they are clearly related to the agricultural and agricultural engineering situation in the area which they cover. This has the great advantage that the requirements, problems and potential of the area can be involved to a greater extent in the activities.

Whereas at national level the projects are, as a rule, aimed in one extremely specialized direction, agricultural engineering projects at regional level have, for reasons of expediency, a certain multisectoral nature. In this way the central concern, the direct transfer of know-how, is linked with, and supplemented by, corresponding activities by means of (primarily informal) training and advisory work. This may include:

- Promotion of the manufacture of simple appliances,
- Setting-up of maintenance workshops,
- Organization of appropriate machinery services,
- Performance of services in the development of training and advisory centres, machinery services etc.

Similar conditions and actual combination possibilities exist as a rule if agricultural engineering development activities take place in irrigated areas. Here, however, the main emphasis is placed on overall agricultural development. Mechanization represents only one component of the whole process, albeit, under most technical and economic conditions, an extremely important one. This means that the concept for the agricultural engineering part of the project must be produced in close coordination with the efforts in other fields of production engineering and organization.

The indisputable advantage of projects at regional level is constituted by the following:

- the area affected can be easily and clearly surveyed,
- the activities are clearly oriented according to regional requirements,
- the spheres of responsibility are clearer and
- there is a shortening of the distance between the sponsors of the promotion activities (and thus also the foreign collaborators) and the target groups of the promotion measures.

Consequently there can be greater certainty that the target will be achieved than there is in the case of measures at national level. The period between input of resources and the point at which they beginn to have an effect will also be shorter as a rule.

It could be said that a disadvantage of regional projects is that their effect is limited from the outset and that only a small part of a country can benefit from a regional meausre. As far as a good "return" on the promotion funds is concerned, it becomes clear that in projects with a regional basis the input of funds must be more or less restrictive depending on the size and the development and production potential of the region in question. As a rule, therefore, regional agricultural engineering projects or the agricultural engineering component of combined projects cannot be of an extensive nature.

However, this shortcoming of the restrictive framework can be counteracted if regional projects perform supraregional functions, as has already been shown by successful projects of this type. Essentially, there are three possibilities:

1. Assumption of supraregional training and advisory functions by regional training and advisory institutions and training of skilled personnel and advisors for other similar institutions.

2. Supervision of, or advisory assistance on, the setting-up of similar institutions in other regions and passing-on of experience, including that in the structural and organizational field (acting as an example).

3. Production of training and advisory material and/or development of suitable training and advisory methods which have been tested and have proved their worth at regional level and which can then also be used by other similar institutions.

All three measures overcome the regional limitations and can be of great importance for supraregional or national development in the field of agricultural engineering. In view of the fact that many developing countries are still without a suitable "infrastructure" for training and advisory work in this field, there is usually a real chance of achieving a considerable supraregional effect with regional projects.

When the decision is to be taken as to whether a national or regional approach should be preferred, most of the arguments – particularly in the developing countries, which are usually several times larger than the Federal Republic of Germany – speak in favour of a regional approach unless the project is concerned primarily with national planning. A national approach may be appropriate only in small countries, such as Sri Lanka, although even here the practical project work was limited to "nonplantation agriculture".

In principle, the more directly it is intended to approach and promote the "final consumers", the more the overall project approach must be limited to specific areas. Projects operating on a national basis with few personnel are totally unsatisfactory and must be rejected. In a large country they are condemned to meaninglessness from the outset unless they are devoted exclusively to training senior personnel to produce a considerable multiplication effect. It is totally wrong and inappropriate to entrust to national projects of this type the task of instructing farmers in the use of machinery and equipment and imparting knowledge of farm management to enable the farmers to assess the costs of processes and machine procurement.

The regional aspect has a particularly strong effect in countries where agricultural engineering has not yet started to develop in practice and where there are for the time being no basic starting points for this development.

If, following careful examination of the various areas and the organizational form of the mechanization, technical development is to be initiated here, it will always be essential to choose a strictly regional development approach. The basic orienta-

tion of the measures must be determined by the prevailing agrarian structure (size of farms) and the desired production programme in accordance with the labour and marketing potential.

This indicates in particular that agricultural mechanization cannot be satisfactorily implemented without appropriate consideration of socialogical and economic factors. Under such conditions both the selection of appropriate forms of traction power (draught animals, 2-wheeled tractors and 4-wheeled tractors) and local development and manufacture of equipment must as a rule be part of the "package" and the terms of reference of most agricultural engineering projects should include as a matter of course training and advisory assistance in questions of farm management to facilitate appropriate use of the technical aids.

In reality, however, the situation is often different. Either the legal, administrative and other structural conditions (e.g. created by autonomous local administrations with agricultural engineering departments) are already developed and consolidated to such an extent that it is almost impossible in the short term to control the procurement of agricultural machinery in the interests of efficient farm management, or (as in most threshold countries, for example) the mechanization process has already achieved such a degree of independent action that a "small development project" can have practically no influence on individual decisions to procure and use machinery. A long-term effect can be achieved only with massive state intervention in the cost and profitability situations.

It is obvious that a considerable proportion of funds should be used to set up the necessary institutions when starting regional development projects in areas where the infrastructure is largely non-existent. Such projects take longer to reach a development target, i.e. a level at which outside assistance is largely unnecessary. The reverse applies to countries and regions which have already attained a comparatively high level of development.

5.4.3 Projects at local level

It does not appear practical to implement agricultural engineering promotion projects at local level, i.e. at the level of villages, individual institutions, enterprises and farms. Experience has shown that this is even to be avoided if the measures in question constitute special training and advisory projects in the field of agricultural engineering. The scope of influence is very limited and the cost-benefit ratio extremely unfavourable even though the level of approach and the target group are closest to each other here and the time required for measures to take effect is shortest. However, assignment of expensive foreign personnel to provide instruction or direct advisory assistence for a few hundred farmers in the use and maintenance of machinery is not in acceptable relation to the value of the technical equipment.

From the economic point of view, skilled personnel from the country in question should, in principle, be responsible for training and advisory assistance in the field

of agricultural engineering, irrespective of whether this is concerned with the and maintenance of machinery or the repair of machines actually used. If necessa high priority should be given to training these personnel at regional level. Not o does this produce a favourable cost-benefit ratio, but the personnel are also fami with the problems of language and customs in the country.

If there is a complete lack of appropriately-trained local personnel and rapid train of suitable staff is difficult, the above-mentioned functions could be performed services by external personnel. However, the employment of highly-paid foreign p sonnel can be justified only if their work at this level can simultaneously act as example and be profitable for other regions and a larger catchment area, perhaps conjunction with other development activities (demonstration as a form of advis assistance). In the last-mentioned case the effect of a local project can almost equ that of a regional project.

Special types of local projects may be constituted by specific services in the field agricultural engineering, if, for example, central workshops and spare parts stor are to be set up in a country where the agrarian structure is concentrated on lar units (cooperatives, collective farms, state farms). The services sector must functio effectively if mechanization is to achieve positive results under such condition Technical services of this nature are important, particularly if the farms in questio each have several thousand hectares of land under intensive cultivation. In such cas it may be practical to implement local projects to promote cooperation in plannir and in the use and repair of machinery and to train local personnel who can subs quently replace the foreign staff.

Such institutions are frequently of a regional nature, at least in part, in that they s multaneously perform central functions for other institutions. Moreover, local inst tutions may develop into production facilities whose products are of use beyond th immediate locality.

The rejection in principle of special agricultural engineering projects at local level which was discussed at the beginning of this section, must, therefore, be placed i its proper context. This applies, for example, to the justified assumption that the ef fect of a project may increasingly extend beyond local limits if the project is success ful. It is at least better as regards promotion of the target group (farmers and rura inhabitants etc.) to start with concrete measures in a specific location and to build upon this basis than to do the opposite and start at a high level, in the hope that something will permeate to the target groups below.

5.5 Scope of activities and equipping of agricultural engineering projects

In order to implement promotion measures and strategies it is necessary to define the scope of activities in conjunction with the level of approach through analyis of the overall economic, operational, ecological and social condtions and the develop-

ment potential thereby determined and to coordinate internal and external programmes and individual measures. It is particularly important that the activities and the project resources supplies from outside be integrated into the framework of responsibilities held by the body responsible for the project in the developing countries. The extent of the necessary project resources and the subsequent success of the project are determined largely by whether the institution in question wields power and influence or whether it can be given these attributes in the initial phase of the project, for input of resources into an institution of this type not only improves the project's direct achievements, but also creates a reliable guarantee that the resources will continue to have an effect following the end of the project.

In principle projects fall into three groups – on the basis of the World Bank's classification scheme – depending on the scope of their activities and the extent to which they are equipped.

- Individual projects (Minimum Package Approach)
- Integrated projects (Comprehensive Approach)
- Special projects (Sector and Special Programmes)

Table 8 (p. 87) shows these project types in conjunction with approaches at national, regional and local level. They may be characterized as follows:

1) **Individual projects** can be implemented at national level by government advisors and planning experts. However, in agricultural engineering they seem likely to have the greatest immediate effect if implemented at regional level, particularly in countries with an adequate level of development and a sufficient infrastructure, i.e. in "threshold countries". At this level the main task of this "minimum package approach" in agricultural engineering development projects is to mobilize a large number of farmers within a short time, to induce them to use innovations and to provide them with the basic skills required to do so. A project has the best prospects of rapid success if limited short-term training and advisory measures are implemented to achieve this target. An individual project can thereby also serve as an introductory period for a multi-phase agricultural engineering development programme.

   The major factor for guaranteeing the success and proper equipping of small individual projects, however, is that the activities should be integrated smoothly into the institution responsible for the project and that they should serve to eliminate bottlenecks or weak spots. This presupposes the existence of an efficient sponsoring institution and, as a result of the small input from outside, the internal situation largely determines the success of the project.

2) **Special projects** for training and advisory work (in other words, agricultural engineering development centres) should be chosen wherever the national authorities and institutions in the field of agricultural engineering at national or regional level do not (yet) provide the necessary preconditions for effective imparting of

Table 8: **Types of Technical Cooperation Projects in Agricultural Engineering**

Level of project approach	Project type (scope of approach and content)		
	Individual projects	Integrated projects	Special projects
National level	Services (advisory assistance to governments, planning)	– Farm development (farming systems) – Production development (individual products)	– Mechanization programmes – Assistance to agricultural machinery manufacturers (setting-up of training and advisory institutions)
Regional level	– Development of training and advisory systems – Skilled personnel for planning, advisory work, testing and training (services)	– Regional development (rural areas) – Production development (individual products)	– Training and upgrading of "multipliers" and "final consumers"
Local level	– Services (machinery services)	– Services (systems)	– Training courses in application engineering

know-how to multipliers and "final consumers" and greater involvement in institution building is therefore necessary. Special programmes have a broader scope and involve above all technical development of equipment, testing of same and/or promotion of the manufacture of simple machinery and aids. Agricultural engineering training and advisory activities should be regarded in this case as a component of the project which must deal consistently with the training and promotion of instructors, advisors and "final consumers", such as farmers, tractor drivers etc.

As far as the assessment of special agricultural engineering projects is concerned it must be added that if they are incorrectly implemented they increase the danger that mechanization will produce harmful socioeconomic side-effects (loss of leased land, jobs, foreign exchange etc.). The socioeconomic questions must, therefore, always be considered in a project of this type.

3) **Integrated projects** (comprehensive approach) are a suitable alternative for providing material resources in addition to know-how and – possibly in conjunction with land reforms or rural development programmes – for creating a new basis for the areas, farms and families covered. This applies in particular to countries where agricultural development is still at a low level and where the prerequisites as regards infrastructure, administration and training are inadequate. However, integrated projects should always be clearly delimited, whether this is a horizontal delimination on a regional basis or a vertical one on a farm-related or product-related basis.

In a project approach of this type agricultural engineering represents only one component, the significance and purpose of which are clearly defined. It is part of the overall development process and can be utilized to provide benefit in individual cases only within the scope of the superposed measures and targets. The great dangers of harmful social sideeffects can thus be successfully countered by the "comprehensive approach".

As far as the equipping of agricultural engineering projects is concerned, the foregoing remarks show that three tasks are always involved. Their extent may vary, but clear priority is always given to the personnel sector:

- Acquiring the necessary suitable personnel, both from abroad and from within the country, for training, advisory work and services,
- providing the personnel with aids to enable them to carry out efficiently the training, advisory work and services and
- procuring funds to promote the institutions.

The external contribution towards implementation of the project depends on the one hand on the project's target and terms of reference and on the other on the level of development and economic capacity of the developing country in question. If it has attained only a low level of development, the country must be concerned primarily about the setting-up of the institutions – the last-mentioned point – for which external assistance may possibly be called upon. If the country has achieved a more advanced level of development and a certain productive capacity it can contribute the necessary institutions and possibly even the aids for the foreign personnel (at least in part). If a country has adequate funds at its disposal (from petroleum, mining etc.) it may perhaps even pay the foreign personnel itself until native personnel have been trained.

Irrespective of the scope of the contribution to be made by the country providing assistance – which is determined by the situation in the developing country – collaboration between the two countries must take the form of true cooperation, which can be achieved if an optimum contribution is made by the country receiving assistance. Service and individual projects also fit into this basic principle for equipping project; in this case equipment meeting the requirements of the country's situation may perhaps also have to be supplied so that the assignment of foreign experts – which is usually comparatively expensive – can be justified.

In order to ensure that the project capacity is being fully utilized, it is thus highly important to carry out a detailed investigation of the country's situation – of the level of agricultural engineering development if a project is to be implemented – so that this may be used as a basis for determining the orientation, extent and equipment of the project.

In view of the fact that training and advisory projects are dependent to a great extent on people and the work which they perform, the wishes and ideas of competent partners in the country concerned must be included as far as possible, for it is the native personnel who have to continue the work, maintain the institution and advance development following the departure of the foreign personnel, who usually collaborate on a project for only a few years. Seen in the long term, the input of funds by the developing country will always be considerably greater than the contribution made by their partner country. The contributions made by the latter, should, therefore, also be chosen so that all the facilities, particularly the technical equipment, can continue to be used with as few problems as possible with the aid of resources from the developing country. This may impose restrictions in two respects; firstly as regards the selection of technical equipment which must not be excessively complicated and which must also be robust, and secondly as regards procurement of this equipment outside the country if usable equipment manufactured within the country is available. It is precisely in the field of agricultural engineering that it is desirable that a development project should provide a stimulus for domestic production, even if this is not part of the declared aim of the project.

5.6 Time horizon of training and advisory projects in agricultural engineering

It has already been pointed out in a different context (see Section 4.3) that every development project involves a process in which the speed of the various phases is determined in part by the input of resources.

If, in order to simplify matters, we work on the basis of a 3-phase model, comprising (1) Preparation and setting-up (2) full operation and preparation of handover and (3) final and follow-up supervision, experience shows that in the case of training and advisory projects at least three years must be allocated for phase (1) if the situation in the institutional and personnel fields is not particularly favourable. A project cannot be regarded as having been fully set up until the major facilities of the project institution are available and at least the most important posts have been filled with suitable personnel from the country in question. As a rule, this necessitates a selective training programme for the counterparts which must be started early on. The length of the setting-up phase is determined to a decisive extent by the availability of counterparts and the level of training which they have already attained. If there is a fairly large number of foreign experts this phase can undoubtedly be speeded up to a great extent (by 1 to 2 years).

Availability of a relatively large number of foreign experts means that phase (2) can be reached earlier: the project institution is in full operation. This has a positive effect on the direct training and advisory achievements in the initial years. However, it is doubtful whether the total length of the project is appreciably reduced, since phase (2) must also include preparation for hand-over of the project to local personnel and agencies.

A project which is started with a considerable input of personnel and funds from outside and operated "at high capacity" also requires considerable expenditure to ensure that it can be properly taken over and continued by the recipient country. This expenditure often cannot be guaranteed at the right time and to a sufficient extent, which means that a considerable drop in achievement then becomes unavoidable.

An informal training project set up with reasonable input of resources will as a rule require a second phase lasting at least three years in order to evaluate the experience continually acquired, assimilate it into the training programmes and develop the teaching aids. However, the institution cannot operate efficiently until it has its full complement of native personnel and the foreign experts can largely confine themselfes to advisory and supervisory functions. Parallel to this, however, the budgetary funds enabling the institution to operate must also be guaranteed. In order to achieve this situation the above-mentioned figure of three years for phase (2) is as a rule a minimum, since the last group of counterparts introdueed to the project must also undergo a period of training and practical experience under expert supervision.

The last phase – handover and follow-up supervision –, for which an additional one to two years must be allocated, can thus start after approximately six years for training and advisory projects. A project can be implemented in a shorter time only if there are extremely favourable preconditions as regards personnel and institutions and, as in the case of a service project, the institutions are already in existence and it is only the time required for training native personnel which determines the number of years needed. Here too, however, at least three to five years will be required for special training and familiarizing the personnel with their jobs.

It is necessary to set a possibly far more distant time horizon if normal training programmes are to be implemented. The fact that most training programmes last between two and four years means that in the case of agricultural engineering colleges where training lasts several years, for example, the first students will not complete their training for a number of years. In view of the fact that an expert eye should be kept on the development and results of at least three age-groups, projects may last between eight and ten years, particularly if the provision of suitable native personnel causes problems.

In conclusion, it should be said that although there is a connection between the input of funds and the speed of a project's effect, increased allocation of funds may enlarge the scope or extent of the project's sphere of influence rather than reduce its length, since "manpower building" and "human investments" cannot be equated with technical production processes. Biological and learning processes are processes of growth, which are determined largely by internal factors. Development conditions can be improved to aid these processes , but these conditions should not be "faked"; although excessive input of external resources can suspend the effect of existing problems, it cannot alter them in the short term. The impact of these problems is all the greater towards the end of an "accelerated" project unless the duration of the project is continually increased in order to eliminate excessive deterioration in the services which it provides.

As far as the length of projects is concerned, it becomes clear that training and advisory projects should be equipped with enough personnel and funds to guarantee that the desired effect in accordance with the project target can be achieved within the above-mentioned time horizon, but that the decisive element must be, from the very beginning, the growth of the country's capacity in the area in question and that the length of a project is determined, in principle, by this component. This means that in countries where training in the field of agricultural engineering must be started practically from nothing eight to ten years are suitable length for a project, whereas in "threshold countries" the project target can be achieved in half this time if extensive institution building in the fields of training and advisory work is no longer necessary.

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