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Social Economic Study
Of the Senegal River Bassin

General Report

Part E

INTERPRETATION OF RESULTS AND RECOMMENDATIONS IN THE FIELD OF RURAL DEVELOPMENT

PART E

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CHAPTER E.I.

INTRODUCTION

E.I.1. The need to interpret the results of the socio-economic study in the perspective of O.M.V.S.'s objectives and development strategy.

Under its terms of reference the socio-economic study of the Senegal River Basin does not aim simply to produce a monograph of the regions' physical environment; it has been specifically designed to collect and analyse the data essential for :

- planning the development of the Basin
- improving development institutions and methods
- selecting and formulating projects.

All this within the perspective of the objectives and development strategy jointly adopted by the member-States of O.M.V.S.

It should be recalled that these common objectives are :

- to provide a dependable income for a maximum proportion of the Sahelian population of the three States
- to consolidate the Basin's ecosystem by promoting a better balance between available resources and their exploitation
- to reduce the vulnerability of their national economies to the vagaries of climate and fluctuating external factors
- to accelerate their economic development by promoting inter-State co-operation.

Within the framework of these objectives, it is the rural development sector which will directly affect the incomes of the greater part of the Basin's population and have an important effect on the ecosystem.

On this latter point, it is the environmental study which should provide the essential technical recommendations. Our study is deliberately limited to those aspects of socio-economic activities wich have significant effects on the ecology of the region. In essence, this means the production of charcoal and the energy requirements of the population ; these have been studied in Chapter B.II. and its findings will be examined in a later chapter from the planning viewpoint.

Another effect of the development of irrigated agriculture is its possible impact on the development of stock-farming by the possibilities it offers of producing fodder in irrigated conditions, and by extra fodder in the form of by-products of irrigated cultivation. Although stockraising will be the subject of a separate study, some aspects of the relation between stock-farming and agriculture will be dealt with in this part of the report from the angle of the effect of agricultural products on stock-raising.

Insofar as concerns rural development based on agriculture properly so-called, we shall interpret the results first from the angle of the contribution of the development of irrigated agriculture to the realisation of O.M.V.S.'s objectives, and then go on to examine the development of non-irrigated cultivation which will need to be organised and developed as a complement to irrigated agriculture in order to achieve higher and more dependable incomes.

Essentially, this concerns the Upper Basin and the Bakel area, where potentially-irrigable land is relatively scarce but where the rainfall would support improved yields from rainfed crops.

E.I.2. The development objectives of irrigated agriculture

The general objective of stabilising incomes, in the field of irrigated cultivation, can be summed up in the following three basic objectives :

- to increase as quickly as possible the pace of site preparation, that is the annual capacity for preparing irrigation schemes and bringing them into cultivation.

- to improve yields and reduce fluctuations in them.

- to allocate plots in the areas prepared for cultivation so as to provide every farmer with an initial patch of irrigated land, the income from which will suffice to meet his family's basic needs.

And so, following the period in which irrigated cultivation has been introduced in the Basin - and this, in spite of some shortcomings, has been a success - it is not simply a matter of moving swiftly on to large-scale development. The configuration of the present distribution of yields shows that there are dangers as well as promising possibilities in initiating the phase of large-scale expansion. If the pace is accelerated rapidly at the cost of lowering yields towards the lower third of existing yields (in paddy rice) which is below 3.5 tonnes for a production cost of I.5 to 2.0 tonnes, this would be a catastrophe from which recovery would be difficult, given that the areas under cultivation will also have increased considerably in line with the accelerated pace of development. On the other hand, if simultaneously with progressively larger-scale development, yields from the new lands could be made to approximate more and more closely to the upper third of present yields (over 5 tonnes) success would be assured.

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The yield target is all the more important inasmuch as costs of production are high, and every additional tonne represents a more-than-proportional addition to income.

Thus the problem is to set up a planning system pursuing at the same time a quantitative objective - the area to be developed and brought into cultivation every year - and a qualitative objective - to improve the distribution of yields " across the board " - ie on all the areas under cultivation. This qualitative objective can be attained only through a coherent action programme covering all the essential factors affecting crop yields.

But it would be illusory to separate, for the purpose of examination, the factors bearing on crop outputs from those affecting enlargement of irrigated areas, since these two objectives are closely linked, and inter-dependent. Indeed, the institutions and methods best suited to promote rapid expansion are those best adapted to the local environment, and therefore most likely also to generate wide-spread high yields.

The aim of ensuring a stable income for a maximum number of the population introduces a further constraint : the geographical distribution of the irrigation schemes. These have to be scattered throughout the length of the Valley if every farmer is to get an initial irrigated plot. This creates more difficult problems for the management of the small and medium-size projects widely distributed through the whole of the valley than for the fewer, larger projects.

Finally, in interpreting the results of the socio-economic report we have to bear in mind the risks of extrapolating from the present scale of development , which is still limited in comparison to that which should be achieved in the future.

Description and critical analysis of irrigated cultivation in its present state of development indicate, from the experience already acquired, its achievements and possibilities, but they also highlight the deficiencies still needing to be corrected. At present, only 20,000 hectatres have been brought into use (including 7,000 used by the C.S.S. (Senegal Sugar Corporation) for industrial sugar production) but the solutions to problems and the institutions and methods to be developed must also be applicable, or anyway adaptable, to a scale of development which will cover 50,000 ha. in the medium term and several hundred thousand in the longer term. Many constraints which at present may seem to be minor obstacles can become major ones when large-scale operations are launched. In interpreting the results we have kept these considerations in mind.

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E.I.3. Definition of the concept of "rhythm" in the work of development

To identify and analyse the constraints on launching into large-scale operations, it will be convenient to distinguish under the term "rhythm of work in development" three principal notions :

- annual capacity for site-preparation
- annual capacity for bringing prepared sites into cultivation
- cumulative capacity for managing all areas under irrigated cultivation.

1. Capacity for site-preparation

This is the capacity for undertaking studies and carrying out the physical preparatory work.

A distinction should be made between the capacity to set up large-scale irrigation schemes, and capacity limited to village-size schemes.

1.1. Capacity for preparing large-scale irrigation schemes

For large irrigation schemes this generally means the capacity to work out terms of reference, and follow up and supervise the execution by the contractor of the studies and works for which he is responsible. In some cases, when these studies and works are undertaken directly by the development corporation, the ability to carry them out must be included. In the first phase of moving into large-scale operations this kind of proceeding will be the exception ; we shall however return to it when considering the institutional aspects of development.

The capacity to develop large-scale schemes must include the sociological dimension for, as we shall show later, the designing of an irrigation system for a large perimeter must take account of sociological and demographic data quite as much as of data relating to topography and pedology.

1.2. Capacity for developing small-scale irrigation schemes

The capacity for preparing small-scale village schemes depends in part on the initiative of the village communities themselves and their capacity to promote and organise the work of construction, and in part on the capacity of the development corporation to select the sites, work out the plans for preparing them, provide technical support for the construction work, and lastly equip the pumping station.

1.3. Capacity to bring into cultivation

This includes the allocation of plots, the organisation of production, and initiation in the technique of irrigated cultivation which includes imparting the basic theory as well as the techniques of cultivation, organisation and management of production. It depends alike on the functions carried out respectively by the development corporation, by the village collectively, and by individual farmers.

1.4. Capacity for management

The capacity for managing all the areas which have been put into cultivation must be understood to include individual plots, the functioning of each irrigation scheme, and of the overall system comprising all the schemes taken together ; covering every angle of production from the selection of the crops to be sown to processing and marketing, products and credit.

It should be analysed on the basis of the following considerations :

- that the cultivated areas increase rapidly in line with the acceleration of the pace of site preparation,

- that irrigation schemes must be geographically well distributed throughout the Basin,

- that the management function must be so conceived as to achieve, efficiently, the aims of narrowing the gaps between yields, raising them, and intensifying cultivation. On this last point one should bear in mind that when the Manantali dam is completed, water will become available, thus all the irrigated areas existing at this date will have to move as quickly as possible from a cropping system, the intensity of which is close to one (because of limited water supply during the dry season)to a system the intensity of which must be close to or exceeding 2.

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CHAPTER E.II.

CONCEPTS OF IRRIGATION SCHEMES AND THE FORMULATION OF A DEVELOPMENT POLICY COMBINING DIFFERENT-SIZED IRRIGATION SCHEMES

E.II.1. Assessment of accumulated experience in the conception of irrigation schemes

1. The overall balance sheet

An assessment of experience gained up to this date clearly shows that the development of irrigation in the Basin has been proceeding on two separate paths, large irrigation schemes and small ones, unrelated to each other (except that from the point of view of agronomy they both rely on the same agronomic research). Only the Guédé experience, to which we shall return, is free from this duality.

An examination of the geographical distribution and present dimensions of the small irrigation schemes shows that their development has pursued and effectively attained (except for the area of Sélibaly-Bakel) the following two objectives :

- to make local populations aware of the fact of irrigated cultivation, and motivate them to undertake it. Although this has been achieved in a crisis period of prolonged drought, we believe that the results obtained can be consolidated in due course, even if we are now to experience a succession of years of good rainfall and favourable flood-levels.

- to bring into being a support base adequate to the task of propagating the technology of irrigated cultivation. Apart from the areas of Bakel and Sélibaly, the existing schemes constitute a network of accumulated experience sufficient to demonstrate the advantages of irrigation and to support the spontaneous extension of its technology to new schemes, so providing a valuable complement to the work of the Corporation's staff and a necessary base for the progressive development of a "home-grown" system of irrigated cultivation specific

to every several part of the River Valley.

As to the large-scale schemes set up in the past, their establishment does not seem to have been related to precise development objective criteria.

The perimeters on the Senegalese side of the Delta were located on the sites of former schemes of controlled flooding which were reconverted into complete water control systems. This is also the case of Guédé. As to Nianga and Dagana, it would appear that two criteria were taken into account :

- favourable topographic configuration
- ease of access.

On the Mauretanian side the choice of M'Pourié as a site and its exploitation as a State farm shows its main objective is that of cereal production. In contrast, Kaëdi seems to have been chosen as much on the criteria of production as on social considerations (heavily populated area) and also with the purpose of setting up a development base in the heart of the Valley.

It is also worth stressing that in the past funding sources have exercised strong and often decisive influence in the choice of sites for development, and of the methods of irrigation and cultivation to be introduced. Whilst these sporadic and occasional incursions, with their tendency to close off the different projects from each other and "balkanise" the concepts embodied in them, may not involve major drawbacks during the introductory phase, they may unless care is taken to prevent it become a progessively-greater obstacle as the scale of development enlarges. We shall revert to this problem when dealing with institutional organisation.

2. Balance sheet of results obtained on large-scale schemes

We confine ourselves here to putting forward a few observations which seem to be important in assessing the basic concept of irrigation schemes.

2.1. The concept of the large scheme has not evolved in the past

Apart from the M'Pourié irrigation scheme, the development of which was inspired by a technological source (Chinese) radically different from the rest, all the other large schemes have been set up successively, from Dagana to Gorgol, on the same model, without using feedback from the operational problems encountered on the earlier schemes to adjust the concepts built into the later ones. They have in

common the following characteristics :

- massive polder-type outer embankments within which a so-called "pilot" irrigation area is developed ; the criteria used for its location are ill-defined but clearly related more to technical/physical considerations than to the human environment. Starting from the "pilot" scheme further areas are developed on the principle of "extension from an inner kernel", the programme being timed - as it seems - more with reference to the availability of finance than to socio-economic development objectives.

- site preparation is entirely mechanised with minimal use of wage-paid labour, and no participation by the local population.

- large size elementary irrigation network (IO-20 ha) conceived to maximise the efficiency of the mechanised equipment, the social organisation for farming being arbitrarily conceived to fit into this elementary unit.

It may be noted that in the working hypotheses used to calculate project cost/benefits, the assumed yields have so far been regarded as data characteristic of the whole region. The optimisation of the cost/benefit equation has thus by implication been limited to seeking ways of reducing costs both of development and of exploitation.

The results of the socio-economic study amply demonstrate that output varies within a very wide range, as I/3 of yields (of paddy rice) are below 3.5 tonnes whilst I5 % exceed 6 tonnes.

Since production costs are high (in the range of I.5 tonne of rice per hectare) incomes - ie profits - vary from I to 3, as between the upper and lower quartiles of existing outputs.

The study has also thrown some light on the main factors affecting yields.

In the search for the optimal scheme it is thus just as important (if not more so) to seek to maximise profits as to minimise costs.

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2.2. The vulnerability of production on large-scale schemes

This is basically due to two closely-related causes :

a) the peasants' alienation from their allocated land and from the technology of irrigated cultivation, reflected in their attitude of passivity and lack of positive reaction when mishaps occur.

There are multiple causes of this alienation, the main ones being :

- the exogenous character of the social organisation of production (farmers'grouping decided by the development corporation)

- lack of control over the processes of production, arising from the fact that some of the essential operations (ploughing, sowing, reaping, threshing) are decided and carried out by the corporation.

- non-participation of the peasants in the work of site-preparation of the scheme, and their installation on fully-developed plots ; this does not induce any feeling of attachment to the allocated piece of land.

b) The excessive responsibilities assumed by the Corporation, which carried out all the functions of collective management and all the decisive operations of production. Moreover, at the level of the Corporation itself the centralisation of management functions and top-heavy administrative procedures make it impossible to react quickly and appropriately to unforeseen incidents in production.

2.3. Problems raised by the cost of cultivation and financial charges

Despite their imprecision, the operational accounts of large schemes show that their present financial costs of production are very high. Notwithstanding direct and indirect subsidies (which will become intolerably heavy as the scale of development increases) the financial charges which the Corporation are obliged to debit to the peasants are such that they can only be recovered by using a form of coercion (control of the crop). This growing indebtedness of the peasants poses a serious problem in the medium and long term. What is more, the amount of these

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charges, and their recovery, necessarily have an adverse effect on relations between the Corporation and the local population.

This accentuates the process of alienation, thereby hindering improvement of yields and the elimination of crop failures. A vicious circle is set up, impeding the enhanced reliability and profitability of production which are essential if the financial charges are to be made more acceptable.

The social organisation of production, whether in the form of producer groups or of co-operative-type associations, does not seem as yet to have been properly mastered.

An analysis of the position at Dagana, Nianga and Gorgol has shown that in this respect a state of latent crisis exists.

3. Balance sheet of results on small irrigation schemes

3.I. Small schemes in the middle valley

During the prolonged drought of the seventies the movement towards developing small irrigation schemes became a self-sustaining process which is now visibly gaining momentum. Not only does every village in the middle valley want its own scheme, but they are all ready to organise themselves to prepare it.

However, the high level of yields obtained in recent years, and the successful management of the schemes by the peasants themselves, should not be allowed to conceal the existence of problems which have not yet been resolved and which, unless remedied in the near future may in the long run undermine or put a brake on the pace of development now achieved, if we should experience a long period of abundant rainfall and favourable flood-levels. In our view, the main problems calling for solution are :

- embanking, and its cost
- the cost of irrigation
- the size of the minimum individual allotment, and of the scheme itself.

These three problems are interdependent, and their solutions will have to be equally consistent with each other.

Whereas on the Mauretanian side the FED (European Development Fund) series of schemes comprises an embankment capable of protecting them against a 10-year flood level, none of the other series, existing or projected, has any embankment. Admittedly, a measurement of working times shows that manpower required for construction of a small irrigation scheme is limited, varying from 250 to 300 days per hectare. Thus work involved in repairs after a high freshet, and flooding, can perfectly well be done by the irrigation scheme's own cultivators. But the financial cost of the ruined crop, the temporary interruption of production and the damage to confidence in the reliability of irrigated cultivation, an important factor in motivation, must not be overlooked. And it must also be kept in mind that the best areas for irrigation - light clay soils on higher ground - will soon be fully exploited and it will be necessary to develop lower-lying land including even the upper levels of the heavier clays (" faux hollaldés = 40-45 % clay). For all these reasons the problem of embanking village schemes will become more and more pressing in the immediate future.

The problem of the cost of water on small irrigation schemes has been mentioned several times ; the size of the " repairs and maintenance " item raises the question of the development corporation's own organisation and management, but it is also linked to the problem we are now going to consider.

There are, in fact, reasons for doubting whether the present size of small village schemes, which vary between 15 and 25 hectares (but in reality are often nearer 15 ha.) is adequate.

The size of individual holdings

A summary analysis of operating accounts has indicated that the minimum size above which an average holding (10 persons - 5 workers) has some chance of providing a cash income over and above subsistence consumption and payment of cultivation charges is about 0.80 ha. (0.16 ha/worker). It has also been pointed out that the area to be allocated, per worker, should exceed this minimum in order to make irrigated cultivation "attractive", and it was for this reason that the draft master plan was based on an allocation of 0.25 ha. per worker.

Villages in the valley, particularly those sited on high banks overlooking the river or major streams are relatively large, often between 500 and 1,000 inhabitants. If we assume 1 worker for 2 persons, and

0,25 ha. per worker, the irrigated perimeter should cover between 62.5 and I25 ha. This amounts to saying that the present village schemes - about 20 ha. - are clearly insufficient. The Matam area provides perhaps the best proof of this ; almost all of the I9 villages which were the first to benefit from an irrigation scheme have applied for a second motorised pump, and to double their irrigated area. The same phenomenon can be observed on the Mauretanian side where in some cases a second scheme has been developed alongside the first, and where most of the others now in cultivation are asking for extension.

3.2. Small schemes in the Bakel area

In the Bakel region performance has been irregular and much less satisfactory. In the first place, this area did not benefit from an initial input of appropriate technology. The movement for village schemes began with a campaign for improved rainfed cultivation on communal fields before settling on irrigated cultivation as the objective. The technical staff brought in to support the initial campaign had no experience of irrigated cultivation.

The S.A.E.D. (Delta Development Corporation) whose geographical responsibility had just been extended to cover this area came in at a time when the village scheme movement had already taken shape, not only at village level but also at the level of inter-village organisation which developed in parallel, and even played a part in promoting the extension of village schemes. In this way tension, conflict and disputes of competence developed from the outset, and prejudiced re-establishment of the situation on proper lines, and improvement of performance. In these circumstances the (otherwise not very noticeable) deficiencies in S.A.E.D.'s institutional approach showed up clearly as major shortcomings. The system of centralised decision and of teaching uniform methods of cultivation, the tendency to impose crop programmes and a standard model of social organisation on all sites, generated tensions, and attitudes of reserve, which prevented the corporation from extending its influence. The supporting staff appointed by SAED, although academically well qualified and often highly motivated, lacked practical experience of irrigated cultivation and were obliged to adopt more authoritarian attitudes than elsewhere, to make up for their inability to overcome initial local reserve, and establish good communication based on their own knowledge and experience.

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Two other factors should have been taken into account :

First, the more favourable rainfall in the region means that rainfed cultivation remains as attractive as irrigated, even in periods of drought, and has a future alongside and complementary to the development of irrigated farming. This explains why irrigation is much less "motivating" here than in the middle valley.

Secondly, this region like the upper Basin traditionally consumes little rice, and to develop new consumption habits will take time. This explains the tendency to substitute maize for rice on most schemes. We shall come back to this aspect in the chapter dealing with choice of crops.

3.3. Small schemes in the upper Basin

In the upper Basin the extension of irrigation schemes is clearly encountering serious problems. In spite of a propaganda and promotion campaign, and of effective support not only by the OPI (Opération Périmètres Irrigués) - which later became the OVSTM (Opération Vallée du Sénégal, Terrakollé et Lac Magui) - but also by the regional administration under the leadership of two successive governors, there are increasing signs that the movement is running out of steam. After a vigorous start which infused in some at least of the peasants an awareness of the possibilities in irrigated farming, difficulties were met as soon as the areas brought into irrigated cultivation exceeded 50 hectares.

From that point on the increase in the areas brought into cultivation has been offset by a progressive increase in the areas left untilled. As a parallel phenomenon, the number of peasants who abandon their irrigated holdings and are replaced by newcomers is continually increasing. This reflects growing discouragement after a certain number of seasons.

Any increase in market gardening production comes up against the obstacle of a limited, uncertain market, and cereal production seems to be checked by a price structure unfavourable to cash cropping, and by consumer habits which effectively limit the growing of wheat and rice. These constraints (price and market conditions) on the possible range of economically-viable crops severely limits the extension of irrigated cultivation in the Upper Basin.

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Finally, here as in the Bakel region, it must be remembered that in the Upper Basin the irrigable land is located in areas of favourable rainfall (above the 600 m. isohyetic contour beyond which rainfed cultivation is viable even in periods of drought, and where scope for improvement can be economically exploited). This must be borne in mind from the point of view both of the reduced incentive to take up irrigated cultivation, and of a development perspective in which the relative importance to be attributed to the irrigated and rainfed sectors must be carefully balanced.

4. A medium-sized irrigation scheme : the special experience of Guédé

That part of the Guédé irrigation scheme on which there is complete control of the water supply comprises three perimeters side by side, each different from the others in its conception and organisation ; one staffed initially by Chinese technicians, one by the CUMA (Coopérative d'Utilisation de Matériel Agricole/ Agricultural Equipment Utilisation Coopérative) and the third managed directly by SAED from its inception. To these must be added the areas developed with full water control directly by the peasants. The whole constitutes an interesting original model as its extent (some 500 ha.) represents what most of the schemes to be developed between now and 1990 will have to become if initial access to irrigated cultivation is to be offered to the entire agricultural population of the Valley. The whole gamut of cultivation techniques can be found there - mechanised cultivation either by contract or self-operated on the large schemes, labour-intensive methods on the small ones (transplanting, hand-finished levelling, manual weeding, etc ...) all applied by the local population with remarkable skill and assiduity. The system of water management is highly flexible, due to a multiplicity of pumping systems, and the adaptability of the hydraulic network is an additional advantage.

E.II.2. Considerations to be taken into account in formulating a policy for a second generation of large-scale schemes

The existing hermetic separation between the development of large and small schemes will have to be corrected. Despite their present success the development potential of small schemes is limited. They do not represent the future, and can only serve as a transitional stage on the way to a development of the Middle Valley in large irrigation units corresponding each one to a natural depression of the Valley.

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It will be necessary to refine working hypotheses and develop hydraulic systems and farming methods which are not only compatible with each other but capable of adaptation to social constraints in a human environment going through radical change under the impact of irrigated cultivation. As we have already emphasised, the search for ways of reducing development and exploitation costs should go hand in hand with a search for policies calculated to produce high yields. The correlations established between output and social organisation amply demonstrate the need to take socio-human factors into account when formulating projects.

It should also be borne in mind that only if schemes have been individually well adapted will it be possible to set up an overall management system capable of functioning satisfactorily when their number has greatly increased, and they will stretch across the whole of the Valley.

In formulating the projects now being prepared, the development corporations have shown their awareness of the need to take these socio-human factors into account, and the SAED intends to encourage peasant participation in their execution.

The Dombo Thiago project is the first such attempt to relate the proposed hydraulic system to village social organisation.

In Mauretania the initial study of the Boghé project has been modified to take account of the constraints imposed by the social organisation of production, and by offering access to irrigated cultivation to all of the population involved.

The implantation of a single irrigated area inside a large-scale polder does not enable solutions to be found for the problems of the entire population whose land has been so enclosed. Would it not be better, wherever local topography permits, to develop first of all the peripheral high lands (fondés) so as to organise them in groups of village schemes, and thereafter extend the irrigated areas, progressively taking in the faux hollaldés (medium clays) and then the hollaldés (heavy clays), according to a plan which would take into account the distribution of population around the main outer embankment ?

The irrigation network of large-scale schemes should be divided into autonomous sections corresponding to a village, and organised accordingly, to be cultivated

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independently. And as far as possible each section should include different types of land - fondés, faux hollaldés, hollaldés (light, medium, heavy clays) a system analogous to the traditional distribution of land for post-flood cropping, which generally consists in dividing each basin into radial bands so that every holding includes high, medium and low-lying land.

In this way the development process could begin on the light clay soils, thus providing each village with an initial irrigated area which would be progressively extended towards lower land. The tertiary irrigation network should be slightly oversized, so as to allow flexibility in the allocation of plots and their cultivation.

The additional cost of this improved and flexible system could in part be offset by participation of the local population in the first stages of construction of the hydraulic network. Levelling techniques should be reviewed, and methods of control, before acceptance of completed work, tightened up.

In practice therefore the planning of an irrigation system for each scheme should be, so to speak, "made to measure" with specific reference to the villages concerned, their agricultural population, their type of social organisation, and the kind of crops they intend to cultivate by irrigation.

This implies that from the earliest feasibility stage development studies should include sociological surveys and stimulation for social organisation. We shall come back to this later. And these studies should supply data, and pointers, in the light of which the technical aspects of the development should be worked out.

In this way, large and medium-size schemes would be so planned as to be able to function operationally as a cluster of village schemes.

E.II.3. Considerations to be taken into account in preparing a second generation of small irrigation schemes

First on already established schemes either the irrigated area must be extended or a second scheme must be prepared so as to provide each farmer with a plot of land sufficient to meet his basic needs (0.25 ha. per worker). In this way we shall move on from the first

objective, which is to interest and instruct the local population in irrigated agriculture, to the second, which is to ensure that they have a sufficient stable income.

Where schemes are to be established, their enlargement from the present 20 hectares or thereabouts to a minimum of 50 hectares, and the need for embanking, imply that the money cost per hectare will be increased and that primitive manual methods must be supplemented to some extent by mechanisation in the excavation of dykes and main irrigation channels.

Considerations aimed at improving the efficacity and reducing the operating cost of the system of logistic support should be taken into account in the process of extension of small irrigation schemes.

The"cluster" development of village schemes around a support centre should facilitate logistic support. Standardisation of machinery and equipment used on both sides of the river, the constitution of a stock of spare parts, and the systematic training of pump operators in pump operation, daily maintenance and running repairs would be highly desirable.

E.II.4. Main lines of a policy of integrated development of irrigation schemes of different sizes.

As we shall see with reference to the master plan for first-generation schemes, the policy of providing access to a first allocation of irrigated land for the whole population of the Valley requires that even before the river flow is regulated irrigation schemes of different sizes will have to be established. This being so, it is very desirable that an integrated development policy should be formulated in which the establishment of small village schemes will be conceived as an intermediate step leading progressively to the development of medium and large size schemes taking in a number of villages, only in a few instances should small scale irrigation schemes constitute the definitive step, where land configuration does not allow their further extension. This means, in particular, that the planning of small schemes must be so conceived as to take fully into account the successive stages of long-term development.

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In such an approach the essential functions of small schemes would be :

a) where conditions are favourable, to help to provide early access to irrigated cultivation enabling flood water levels to be controlled, and to take a first step towards assured regular income.

b) elsewhere, to serve as a primer for the development of large and medium scale schemes. First, to help in the process of acquiring the technology needed to obtain high yields, and reduce the vulnerability of the larger schemes within which they would subsequently be incorporated (or of those on which the village population so initiated would be settled). Secondly, to set up the core of a social organisation which could later be expanded. Thirdly, to ease the solution of the land rights problems posed by the development of irrigation in the Oualo land.

In fact, experience has shown that the establishment of village schemes on high-lying land not very suitable for cultivation by traditional methods raised only minor land rights problems which were easily settled. The preliminary phase in developing a scheme on light clay soil, giving everyone a high-yielding plot, would depress the value of Oualo land and thus make it easier to settle land rights questions there.

At the same time the demonstrated advantages of irrigation would promote the consensus needed for its extension to Oualo land.

c) to play, thanks to their flexibility and adaptability the role of pre-extension work in the development of institutions and methods better and better adapted to the socio-economic and human environment of the Valley.

To conclude this review of the concepts of irrigation schemes ("perimeters") we wish to make a final remark. There has often been a tendency to approach the problem of accelerating the pace of development from the point of view of needed improvements in the organisation and managerial performance of the development corporations. We are inclined to think that whatever the level of efficiency attained by these agencies, it will not be possible to achieve a high rate of development without revising the concept of irrigation schemes so as to fit them better to the specific environment of the Valley.

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CHAPTER E.III.

THE NEED FOR AN INSTITUTIONAL FRAMEWORK WHICH CAN BE QUICKLY EXPANDED

E.III.1. Definition of the problem

Under the term "development institutions" we include all organisations taking part in the process of production and marketing, whether they are organisations set up by the farmers themselves, such as producer groups, village scheme management groups, co-operatives, groups of co-operatives, or State corporations responsible for regional development : SAED, SONADER, OVSTM ; for marketing : ONCAD, OMC, OPAM, and for credit (BNDS in Senegal - not yet set up in Mauretania and Mali), or supporting research institutes (ISRA, CNRA).

Be it noted that we do not propose to review these institutional developments in their entirety, but only to interpret the results of the socio-economic study from the point of view of the institutional constraints which hinder rapid expansion of irrigated cultivation, in order to pick out the course of action to be followed.

To be more specific, we shall try to determine, in the light of experience, what distribution and interaction of functions between the bodies set up by the peasants themselves, and the development corporations, is best suited to bring about a rapid increase :

- of the annual capacity for irrigation scheme site preparation
- of the annual capacity to bring these sites into cultivation
- of cumulative management of all areas under cultivation.

Of these three capacities, it is the last which is the most difficult to evaluate, and which could constitute a limiting factor able to slow up the pace of development, if we remember that rapid expansion of the areas under cultivation must go hand in hand with the qualitative

objective of high yield. The building up of management capacity deserves serious scrutiny, the more so since the effects of under-capacity will be felt only with a certain time-lag and lead to situations which will be difficult to control and correct, years after the capacity for the preparation and cultivation of irrigated areas has already been substantially increased.

The example of left bank schemes, in particular those of Nianga, Dagana and even Guédé which in the past was a model of performance, well illustrates the point that problems relating to management capacity need to be anticipated and not tackled when an imbalance between increased capacity for site preparation and cultivation on the one hand, and deficiencies attributable to over-stretching of management capacity on the other, has already produced overt and concrete results.

In fact, on the Nianga and Dagana schemes failure to keep up the irrigation channels will soon put a stop to cultivation in order to allow the hydraulic system to be restored.

Moreover, tillage delays become progressively more serious from one season to the next, and have even spread to the Guédé scheme, where part of the equipment has had to be diverted to adjoining schemes. The cumulative effects of interrupting production to repair the irrigation system, and of the drop in production resulting from late sowing (as a result of late ploughing) cannot fail to impair the peasants' motivation, not to mention the aggravation of their indebtedness and their relations with the development corporation. These phenomena are compounding each other to make more difficult the rehabilitation of the production process.

In our view, the balance to be sought between capacity for site preparation and exploitation on the one hand, and managerial capacity on the other, requires careful study of institutional interaction and the allocation of functions between the development corporation and village organisations in order to set up a management system which will right from the outset take into account the constraints of future large-scale development.

The approach to co-operation between development corporation and village organisations must be dynamic and forward-looking, from the stage when cultivation begins through to the point at which "cruising speed" or "normal" operation is reached.

In the first phase, the peasants are not yet experienced, they have still to learn and master the technology of irrigated cultivation. And their village organisations have not yet completed their apprenticeship in organising and managing the collective operations of an irrigated scheme. Thus the capacity for putting into cultivation will depend mainly on reinforcement of the capacity of the development corporation, which must necessarily play a more important part during this first phase.

But thereafter, unless the corporation shifts a good part of its responsibilities to bodies set up by the peasants themselves, it will become less and less able to increase its capacity to prepare sites for further schemes and bring them into cultivation, and - even worse - it will be even less able to perform its overall management function effectively.

Successful expansion thus depends on the introduction of a system of rapid devolution and sharing of functions and duties between the corporation and the peasants' organisations.

This implies that the following main conditions are met :

i) that the corporations concentrate their efforts on increasing their capacity to prepare irrigation schemes and bring them into cultivation, and by the efficiency of their action in this phase to minimise their role when the "cruising speed" or normal operation stage has been reached ; this ought to be fairly soon (2-3 years).

ii) that the peasants' organisations are adapted to local social conditions, and that the guiding principles adopted for the development of irrigation schemes are compatible with local social structures. (This point has been dealt with in the preceding paragraph).

iii) that when the stage of normal operation has been reached, each scheme can function to a maximum degree of autonomy and independence, with a minimum need for supporting services in production, and marketing.

iv) that the system of extension work, of diffusion of technology at grassroots level, training programmes for both development corporation and local organisations' staff should, in quality and quantity, be conceived in terms of the planned rate of irrigation development and be consistent with the distribution of activities and responsabilities between the corporation and village organisations from the stage of initial exploitation through to that of "normal" cultivation.

In order to lay down the main lines of a policy designed to make the best general allocation of these functions from the start, it will be advisable to have a look at what has been achieved by way of institutions during the period of introduction of irrigation in the Valley.

E.III.2. Assessment of the organisations set up by peasants practising irrigated cultivation

1. Institutions at village level

The socio-economic study has shown that amongst the institutions set up by farmers themselves, it is village organisations strongly rooted in their traditional milieu which have proved to be effective in the management of small irrigation schemes.

If there are still fairly widespread weaknesses in water management, overdependence on logistic support by the development corporation, and not infrequent deficiencies in the upkeep of irrigation channels and water pump, all this can be corrected by organising these duties and training people in them. Experience has already shown that such bodies can provide the framework for harmonious and dynamic development work, and can become basic management units not only for small schemes but for the village sections on large and medium size irrigation schemes.

It is worth remembering also that they have been efficient not only in organizing the construction work of small schemes but equally in settling the land rights questions which tend to crop up when sites on high land (fondé) are being prepared. The campaign to "motivate" the local population in the Boghé project suggests that they could also play an important mediatory part in settling such questions when Oualo lands are concerned.

Experience also shows that the heterogeneous producers group set up in large irrigation schemes is not stable ; they tend either to disintegrate into their individual components, or to split into smaller sub-groups based on traditional affinities.

This experience on large-scale schemes can be compared with that of Bakel, where SAED's efforts to improve its chosen model have resulted in tensions detrimental to the improvement of output.

This all tends to show that in the environment of the Valley, attempts by the administration to impose a pattern of social organisation have not had happy results. This does not rule out an active role in stimulating and assisting the population to set up their own organisations. In this connexion, the part played by the Co-operative Department in Mauretania in the initial phase of promoting the village irrigation scheme movement should not be forgotten ; nor the promising early results obtained by SONADER in its sociological "spadework" to prepare the way for the future Boghé irrigation scheme and its social organisation.

2. Inter-village organisations on small irrigation schemes, and co-operatives on large ones

The only inter-village group linking village organisations on small schemes is the one which was set up in the Bakel area. Unfortunately, as already noticed, the circumstances in which relations between SAED and the federation of village irrigation schemes were first developed did not conduce to co-operation, and were marked by disputes, claims and counter-claims giving rise to uneasy compromises. We believe, however, that this situation can be redressed if SAED's policy of decentralisation is put into effect, and accompanied by an adequate programme aimed at improving the peasants' ability to master the techniques of irrigated farming, and combining the training of pilot-peasants with that of extension workers.

For the village schemes in the districts of Matam and Aéré Lao, the SAED intends to promote co-operatives grouping all the villages of each zone.

On the large-scale schemes in the Delta, the co-operatives which were set up by the administration at the time when controlled flooding was practised have not (up to a recent date) proved to be the right framework for collective management, and this has impelled SAED to establish producer-groups as intermediate organisations.

However, since the recent introduction by SAED of its "decentralising" policy, the co-operatives are working much more cohesively and efficiently, and now carry out satisfactorily the following main duties :

- allocation of newly-prepared land to peasants, and imposition of penalties on defaulters,
- management of credit, including allocation of seasonal credits, collection of dues, and if necessary forfeiture action against defaulters,
- fixing of the calendar for mechanised cultivation, subject to readjustment in consultation with the responsible SAED official,
- organisation and management of the water supply rotation system with SAED technical assistance,
- allocation of production between subsistence needs, production for the market to cover advances to be refunded, and cash income.

Follow-up of decisions taken is carried out much more efficiently by the co-operatives now than when it was the responsibility of SAED. And relations between SAED staff, the co-operatives' boards, and the peasants have greatly improved. The image of SAED staff as "policemen" responsible for law and order in the irrigation areas has faded, giving way to one of advisers and technical assistants to the peasants.

In Mauretania on the M'Pourié scheme the co-operative formed by peasant-producers of six village communities has proved itself to be efficient and well-organised.

On the Gorgol polder, instead of a co-operative group a landowners' defence association has emerged ; its initial solidarity is very strong, and its influence every season threatens the functioning of the scheme. Thus, not all the local bodies coming spontaneously into existence are favourable to irrigation ; when they are dominated by the vested interests of one class of the population they can have harmful effects not only on cultivated irrigation itself but on the social implications of development. This extreme example shows that, although it may be desirable for the corporation, and the administration, to abstain from imposing or directly promoting a type of social organisation on the peasants, they must play some part in encouraging the setting up of social groupings of those involved in the production process, and in seeing that these organisations are socially equitable.

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E.III.3. Assessment of the development corporations

In Senegal the problems encountered at Nianga and Dagana, and the increasing vulnerability of Delta irrigation schemes (and even of Guédé, heretofore a model) are clear indications that SAED has expanded its capacity for constructing and bringing into cultivation new irrigation schemes while its capacity for management of existing schemes was not restreamlined to match the increasing scale of development. In fact, the extension of SAED's competence and activities from the Delta to the whole of the Senegalese Valley has been effected by the simple transposition of methods and institutions employed in the Delta without sufficient attention being paid to new dimensions of distance, geography and environment. It is only recently that an attempt has been made in the Delta, with initially encouraging results to decentralise management and give more responsibility to the co-operatives.

In Mauretania, the division of responsibility for the development and management of irrigation schemes between the Department of Agriculture (for schemes managed with the assistance of FED - European Development Fund -) and SONADER was terminated a few months ago by transferring the Department's responsibilities to SONADER. But the M'Pourié scheme is still administered by the State farm of that name, and the old and new schemes at Belnabé by the National Centre for Agronomic Research.

Since it officially came into being in 1975 and its activity really began in 1976, SONADER has rapidly increased its capacity for developing irrigated areas and bringing them into cultivation. These results have been obtained, in part, through its policy of putting maximum responsibility from start to finish into the hands of the village communities. It is too early to see whether this policy may have set up an imbalance between the capacity to bring into cultivation and the capacity to manage. But it may be noted that in the system envisaged by SONADER an important element is the training of pilot-peasants from the earliest stage through to that of normal routine farming. For various reasons, the plan has not yet been introduced, and this seems to throw doubt on SONADER's ability in the medium term to achieve stable performance. In our view, it would be advisable to give special priority to this project, and to the search for finance to implement it.

In Mali, the pace of development of small schemes continues to be slow but this is not due to lack of capacity of the O.V.S.T.M. to develop and administer, even though its responsibilities have been extended to Tarakolle and Lake Magui. As already explained in Chapter C.I., effective exploitation of the areas developed for cultivation is limited by the major constraints of outlets and prices.

E.III.4. Interaction of the functions involved in promoting and developing irrigation schemes

1. Small village schemes

The present system seems to be generally adequate and calls only for minor improvements and adjustments.

It is the function of motivating the farmers and of providing technical assistance for setting up village organisations that most needs to be reinforced or introduced. It could be undertaken by the development corporation or, in view of the latter's heavy responsibilities in the period of "take-off", perhaps by a special extension service working in liaison with the corporation. At present, the aim of extension work is not to motivate people to take up irrigated cultivation, which is already widespread except in the Bakel region, Sélibaly and the Upper Basin, but rather to stimulate the emergence of leadership across the barriers of traditional social stratification, provide technical assistance for working out rules and regulations, and arrange for a fair allocation of the irrigated plots, as well as to set up and administer working funds.

Similarly, the training and strengthening of site development teams, responsible for selecting sites, drawing up plans and providing technical support in the work of preparing small irrigated areas, deserves special attention. The study has shown that a substantial proportion of low yields has been due to some inherent shortcoming in the ground plot itself. Water charges also are high, and the reduction of loss and wastage by improvement of the hydraulic system and better quality work on the irrigation channels is much to be desired. The resulting development costs will be more than compensated by increased yields and reduced operating costs.

Finally, it should not be overlooked that in the near future a growing number of village schemes will need to be protected by minor embankment works, and a start should be made, now, on testing concepts and methods of construction combining manual labour with the use of mechanised equipment.

In our view, the right policy would be to minimise the use of machines in favour of labour-intensive methods, not only to reduce the cash investment, and under-employment, but even more to arouse in the peasants a sense of attachment to their allotment and their irrigation scheme, and avoid generating passivity and alienation vis-à-vis irrigated cultivation, or the attitudes which can presently be observed on large-scale schemes.

The main questions to be answered are the following :

- apart from the outer embankment, should earth-moving equipment be used to dig the main irrigation channel ? To settle this question, we need better knowledge of present water losses on the village-scale irrigation networks, and to compare them with the new site at Belnabé recently completed by the Agronomic Research Centre, using earth-moving machines.

- should earth-moving equipment be used for levelling, and to what extent ? This question should not be studied with the object of finding a standard solution capable of being generally applied ; but rather to identify the topographical situations in which machines are necessary to create a surface on which the final levelling process can be carried out by manual labour.

In this experimental programme it will be important to assess the effect of the reduction of manual work on the farmers' attitude to irrigated agriculture, and the effect of the latter, in turn, on yields. A close watch on performance in the next few seasons on the new irrigation scheme at Belnabé would be well worth while.

2. Medium and large-scale schemes

If the conception of large and small schemes had to be recast to fit the social context, the development corporation and the regional administration would have to take on functions involving community development in addition to their technical responsibility for the planning and execution of works.

This social programme would have to be linked with the various steps of project study from feasibility to construction design.

At the stage when a feasibility study is begun a preliminary sociological survey should be launched to identify the populations involved in the development, analyse the nature and acuity of the land rights issues

to be resolved, and seek out the persons and groups who could be mobilised to take a lead in the future in the social organisation of the site. Finally, it will be necessary as well to assess the degree of homogeneity of the village social structure in order to adapt the layout of the irrigation plan according to whether the village is likely to work as a single entity or should be divided into a number of sub-groups more or less inter-dependent.

The maps and listings by the ORSTOM (Léricollais) study of population and land utilisation in the Valley now being published, in combination with the socio-economic study and with population data broken down by natural irrigation unit, provide basic material for carrying out this first sociological survey.

Its results should enable a decision to be taken on whether the project can be carried out in a single operation taking in both the Oualo lands and the light clays, or whether it would be better to take it in two stages, the first being to establish village schemes on light clay, the second to develop, progressively or not, the Oualo land.

On the basis of the information provided by the first inquiry, and preferably before planning the project's execution, the regional Administration with the support of the development corporation and of the local personalities and groups who have been picked out, should start a campaign to arouse interest in the issues, and provoke debate on the advantages, obstacles and problems posed by the eventual carrying-out of the project, and on whether it would be worth doing at all. The aim of the campaign would be to stimulate a demand for the project by the population, through their village institutions, and to initiate its future social organisation by setting up village committees for its implementation. At, and from, this stage the principle of the population's participation in carrying out the construction works should have been accepted.

Should this campaign fail to produce positive results, it would be better to defer the project rather than carry it out in conditions which would certainly lead to poor exploitation of the project area, and to over-heavy responsibility being thrust on the development corporation at that stage. Development planning should allow for these uncertainties of timing in the execution of projects, and prepare an adequate portfolio of feasibility studies.

We also suggest that in the light of a study's findings the regional Administration should bear the principal responsibility for stimulating local interest and thereafter settling land rights questions, as we are

convinced that these can only be resolved by firm government action, and that the development corporation's role can only be an auxiliary one.

When the feasibility study has been completed and the work is to begin, the main lines of the development scheme should be explained to the local people, through village "initiative" committees, and that there should be a discussion from which suggestions for changes calculated to adapt the project to the wishes of the population might emerge. This discussion could also bring into being the inter-village group destined to take part in the future management of the scheme, and would likewise serve to stimulate awareness of the need for mediation between the interests of the communities concerned, and introduce principles for settling differences on the basis of compromise.

Whilst the plan of the work to be carried out is being designed, the task of dividing the land into parcels and defining the rights attached to each parcel should, in our view, be entrusted to village organisations, with the help of the development corporation, which would take over all the technical topographical work. But the verification of traditional land rights will oblige the regional Administration to take decisions, after consultation with the corporation and the village communities. It is during this phase that the "initiative" comittees should turn themselves into village organisations for the establishment and management of the future village sections of the scheme, and that the inter-village co-operative organisations destined to take part in the management of the whole irrigated area should begin to take shape.

To adopt this concept of studies incorporating sociological as well as technical aspects in the planning of projects implies reinforcing the capacity of the development corporation to undertake sociological studies. We think that such studies should be carried out by sociologists attached to the corporation and with adequate knowledge of the human environment of the Valley, rather than by outside consultants supplied by the consulting engineering firms.

On the technical control of the studies and work to be carried out we have already set out our main comments in discussing the revision of irrigation scheme concepts. Here we wish only to stress that this revision requires that the terms of reference of the studies be prepared by multidisciplinary teams combining the social, economic and agronomic aspects of the project with the civil engineering component.

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Another institutional question which needs to be tackled is that of work carried out directly by the development corporation. As the corporation must in the medium term acquire the equipment and material needed to prepare small sites, the possibility of its carrying out similar construction work on large schemes cannot be ruled out. But this should be kept to a minimum during the take-off period, and the undertaking of work directly should be essentially in order to keep contractors' prices within limits set by competition. In this connexion it might be interesting to examine the possibility of giving the corporation - ie its service responsible for such work - financial autonomy and requiring it to observe contract conditions similar to those agreed with contractors.

It would be useful to associate the village and inter-village communities with the inspection and acceptance of completed work, in particular the work of levelling individual plots of land.

Finally, an important point to which we wish to draw attention is the part played in project studies by those who are putting up the money. It is absolutely normal, and justified, that sources of finance should retain the essential right to assess and select the projects they are asked to finance. On the other hand, it is equally essential to maintain a unity of conception and exploitation in developing the different projects. These two constraints seem to be compatible if the following conditions are observed :

- the master development Plans must be flexible but realistic. They must be flexible enough to allow funding sources to choose projects in accordance with their own financial constraints and technical standards. But the priorities must be clearly set out, and the technical norms of preparation and development, and the socio-economic norms of organisation and exploitation must be carefully established so as to keep the available choices of concepts and methods within limits compatible with the requirements of large-scale development. And it must especially be borne in mind that too many priorities in the plans mean in pratice no priority at all, for then any kind of project can qualify for inclusion in the Plan.

- the services of the development corporation responsible for liaison with the funding sources, and their co-ordination, must include in their staff pluridisciplinary personnel well experienced in

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the problems of the Valley, and sufficiently imbued with the strategy of the master Plan to be able to serve as guide and effective interlocutor for the various missions called in to identify, assess and prepare projects with which it is desirable that they should be associated.

E.III.5. Organisation and distribution of functions in irrigation schemes during the period of initial exploitation

To launch this new technique of cultivation successfully, and ensure an adequate ongoing management system, much will depend - it seems to us - on the training of qualified personnel within the farming population for technical work (pilot peasants, irrigation wardens, pump operators) as well as for the management of cooperatives and the processing of products. One of the most important duties of the development corporation, in our view, is to take over this training function not only for its own grassroot extension workers but even more in order to train staff drawn from the peasants themselves. The problems it raises will be discussed in the next chapter ; here we wish simply to make the point that training peasant cadres should be the job of the corporation and not of some third party such as the national vocational training service. Experience has amply demonstrated how unsuited classical vocational training methods are to prepare instructors for the work of initiation, transfer of technology, and the transformation of social organisation implicit in the passage from traditional agriculture to irrigated cultivation. Only the corporation responsible for dealing with these problems is in a position to work out appropriate and essentially practical training aiming to initiate farmers in the proper working of their organisations and the effective application of new techniques of cultivation. It would be best for these locally-recruited cadres to be trained during the phase of site preparation, before cultivation is begun. Their selection should be left to the village organisations, subject to observance of rules to be laid down by the corporation to ensure proper representation of different ethnic groups and castes in the candidates selected, and of aptitude criteria to be applied to candidates for such jobs as pump-operator, irrigation warden ...

Another important point is to examine alternative strategies of extension work . The problem is either to set up from the start an extension system intended to be the definitive and permanent one, or to conceive two extension systems, the first more intensive one to be applied during the phase of initial exploitation when the need of the farmers for guidance and support is greater, which will

be phased out and replaced by looser support once farming practices and management have become routine.

From our own observation, we believe that the second is the better of the two. Both extension workers and peasants feel that the need for advice and help is much greater in the first few years, and the peasants' permeability to advice from technicians declines as the local population masters the requisite technology. It is also recommended that staffing costs during the first phase of cultivation should be included in the overall investment cost of site preparation. This additional charge is amply justified by increased output, lowered staffing costs in the succeeding period, and most of all by lightening the corporation's subsequent work load.

The question is not simply one of how much support should be provided to initiate in the new techniques of cultivation, which depends on the number of pilot-peasants in the scheme, but rather of the technical cadres helping in the management of co-operatives and the organisation of work, cadres who should all be phased out in two or three years. This programme of temporary staffing should be regarded as complementary to the training programme preliminary to the start of cultivation. But although this staffing system is basically intended for the management of large schemes, it would be worth while also to envisage a looser, lighter form of help to improve the organisation and management of small village schemes. This could be done by organised visits from technical staff posted to the larger schemes.

To sum up, the initiatory phase of cultivation should be seen as the phase for installing and "running-in" production structures in the peasant milieu with a view to achieving functional autonomy at a later stage, thereby minimising the corporation's need to intervene and assist. This aim should be realised through a training programme to be set up before cultivation is started, and to be closely supervised for two or three years. Training and staffing costs during this initial period of cultivation should be treated as an initial investment to be added to the site preparation cost of an irrigation scheme.

E.III.6. Organisation and distribution of the functions of the overall management system (in the phase of routine operation following the period of initial exploitation).

1. Different levels at which these functions operate

It should be remembered that overall management involves functions at three levels :

a) - those to be undertaken at the level of each scheme, from (relatively) small sites involving a single village, through medium-size schemes involving two or three villages, to large schemes taking in a larger number. Nor should it be overlooked that, in many cases, at a later stage small village schemes will be incorporated in larger schemes and that medium and large-scale schemes are intended to be progressively enlarged.

b) - those to be undertaken at regional level. By "regional" level we mean the intermediate subdivisions set up or to be set up by the development corporation between its own central level and "scheme level", such as the inter-village organisations which could come into being either spontaneously or under the impulsion of the corporation. This intermediate regional level may itself change with the passage of time, or be subdivided, as the number of schemes increases. Both SAED and SONADER have frequently used the term "pole of development" to signify the base from which regional activities should be exercised, but without specifying clearly whether it refers chiefly to a logistic support base or to a growth centre strategy to promote secondary and tertiary activities based on a certain number of regional centres.

c) - those to be undertaken solely at the level of the corporation's own central administration. However, the eventual representation of the peasants themselves in the corporation may take different forms, and the desirability of providing for it is worth consideration.

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2. Guiding principles determining their distribution

The principles on which a management control system should be based are the following :

a) maximum self-management of each scheme whatever its size. But this autonomy should by no means imply stringent separation one from another. And in particular the logistic bases of the bigger schemes and the higher échelons of their technical staff (especially those responsible for the "poles of development")should be also at the service of small and medium schemes.

b) distribution of functions between the development corporation and the village organisations at the triple level of irrigation scheme, region, and centre, so conceived as to encourage co-operation and the creation of machinery calculated to correct deficiencies by mutual compensatory action.

Experience has shown that the local population's relations with the development corporation are always marked by two contradictory attitudes :

- on the one hand, an antagonistic and demanding attitude

- on the other, dependence and co-operation.

A scheme functions best when these two attitudes are in balance.

The distribution of functions should be so arranged that action by the village organisations will tend to correct the deficiencies of the corporation in the discharge of its responsibilities, and conversely that the corporation's control over them, arising mainly through the set of rules on dues and obligations, should serve to remedy their weaknesses and improve their cohesion. It is (as we see it) when this balance is achieved between the corporation's responsibilities and those of the village and inter-village organisations that a spirit of co-operation can best develop, and machinery can be established tending automatically to offset deficiencies and mishaps in the process of production.

3. Functions on small schemes

The functional autonomy of small schemes is virtually ensured already by the present approach. Improved performance of their functions is essentially a matter of

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training pilot-peasants in methods of cultivation, pump operators in operation and maintenance, irrigation wardens in water management. The technical assistance provided during the initial phase should underpin improved management organisation and training.

The next chapter will deal with the location at selected points throughout the area of repair-mechanics who could cut breakdown and repair costs on the smaller schemes by reducing the need for action by the corporation to major repairs.

4. General considerations concerning (i) organisation of functions on large and medium size schemes, and (ii) regional functions

As regards large and medium size schemes, we shall do no more here than identify their internal functions and set out the main lines of their allocation, whilst insisting that it is no part of our task to recommend any one solution - there are many - but simply to give some indications in the light of experience on the organisational principles involved.

However, account should always be taken of the size of the irrigation scheme, and of its enlargement over a period of time, as many schemes are developed through successive phases.

We shall also take together both the functions internal to the scheme, and those in support of adjoining irrigated areas. As already emphasised, maximum internal autonomy must be combined with mutual interaction and support between irrigation schemes of different sizes, in order to ensure an overall system of management which is economical in its use of material and human resources, and works efficiently.

Likewise, we assume that the irrigation network has been planned with due regard to social organisation within the area of the scheme, as described in the previous chapter, ie :

- that the perimeter is divided into hydraulic sections or "quarters", corresponding specifically in size and geographical situation with each of the villages sharing in the development.

- that each section's hydraulic system should be as autonomous as possible.

- that the size of the basic irrigation network should not be too big (IO-I5ha.) and should be planned so as to allow either for collective cultivation (eg the SONINKE area) or for individual cultivation, but subject to common rules, and for its eventual transformation, by the work of the peasants themselves, into two or three sub-divisions.

Insofar as concerns the peasants' social organisations, we assume that they will exist at three levels ; the intervillage level grouping all the communities exploiting the irrigation scheme ; the level of the village cultivating one section ; the level of the irrigation division (or sub-division) grouping a corresponding number of collective or individual farmers.

The functions we examine are the following :

5. Operational functions

These comprise :

- technical support.
- organisation of the seasonal programme according to choice and allocation of the crops to be planted.
- water management.
- seedstock.

5.1. Technical support

The phase of initial cultivation of the irrigated area corresponds to the period when farmers are initiated in the technology of irrigated cultivation and the ensuing period when exploitation has become routine is a period of assimilation of technology in which the technical package is continously adapted and improved.

During this latter phase a network of experienced pilot peasants will be available to provide leadership and technical support on the ground.

The development corporation's technical support will be chiefly directed to :

- facilitating the assimilation of technology. This is basically an educational role to enable

the peasants to move as quickly as possible from the stage of the "How" of farming methods to the stage of understanding "Why" these methods and inputs are used, and what are the main characteristics of each input.

- to look out for "early warning" signs of new cultivation problems and to advise on appropriate action. This is mainly keeping a watch for pests, crop infestation and plant diseases.

- to promote and lead discussion between peasants to improve their work-organisation and farming methods.

- to spread knowledge about, and advise on the application of, recent findings in agronomic research.

From this enumeration, it follows that the corporation's technical support function need not require a massive staff, but its basic members must be of sufficient technical level (intermediate level).

5.2. Choice and allocation of crops to be planted, and their programming

This implies discussion between the development corporation and the peasants' organisations at the double level of the village sections within the irrigation scheme, and of the intervillage organisations representative of the whole irrigated area.

Preparation of the seasonal plan for each scheme could start with the drawing up by the intervillage organisation, with the corporation's agreement, of general rules for working out a programme for the season section by section. When the sections have put forward their proposals, the corporation and intervillage committee will adjust them to fit the proposals into the overall irrigation scheme programme, taking into account in particular the constraints of water management and possibly of mechanical equipment availability (where its use is under the corporation's direct control and responsibility).

The initial experiment in decentralisation carried out in the Delta by SAED tends to show that this procedure is feasible, and promotes harmonious and effective co-operation.

5.3. Water management

Within the policy of cutting back to a minimum the corporation's own operations, its water management function should stop at the boundary of the village section. The village organisation itself should be responsible for its distribution from the water points down to the basic group within which responsibility for water use would be a matter for the group itself.

This system implies that irrigation wardens will be trained in every village.

5.4. Carrying out mechanised work

Responsibility by co-operatives for the use of mechanical equipment is at present virtually limited to the CUMA (Co-operative for the Use of Agricultural Material, at Dagama). Experiment in this field should be pressed on, and as soon as a proved system is ready it should be brought into general use. Apart from relieving the corporation of these functions, the CUMA would have the advantage of turning into a direct farming cost what at present appears to be a due paid to the corporation. This will improve relations between the latter and the peasants, and at the same time eliminate an important factor in their estrangement by giving them control over agricultural operations which can be crucial to their success.

Amongst other considerations, the CUMA experimental programme should take into account the following :

- the scale should be sufficient for its operating conditions and costs to be in line with those of the future scale of development.

  In particular, the training of the CUMA's specialists and management staff should serve by feedback to improve the programme itself and its training methods.

- support and technical assistance (including expatriate technical assistance) by the corporation to each experimental CUMA should be limited to the functions which the corporation could reasonably assume in later large-scale development.

- the experimental programme should also aim to identify the maintenance and repair functions to be undertaken by the CUMAs and separate them from those to be carried out by a central workshop.

The programme should also be devised so as to provide information on the most appropriate size for CUMAs, and on their equipment. This means that they should be tried out at village level, and at the level of a basic irrigation network, with medium and light mechanisation units.

Assessment of the programme should be sociological as well as technical and economic. And from this point of view there would be advantage in arranging an experimental programme covering different types of CUMA over the whole cultivated area of one or two large-scale perimeters, selected to include the Valley's major ethnic groups. This would enable the optimal CUMA to be determined in the light of the sociological factors conditioning each human milieu.

Experimentation on the scale of a full-size irrigation scheme will enable a central maintenance system providing logistic and technical support for the different CUMAs to be properly organised.

Apart from the CUMAs, it might be worth while to try contracting work out to the private sector. Action on these lines has already been started in the area of Rosso on the Mauretanian side. Such action could take one of two forms ; granting of credit and investment facilities, and technical assistance to the contractors.

5.5. Production of seedstock

As already noted in Chapter B.III. the production of seedstock is especially important for the long-term stability of output on irrigated land. It is a main factor to be watched if the proliferation of weeds, pests and diseases is to be obviated. Experience in the Basin in particular and in West Africa in general has shown that seed production on State farms has numerous drawbacks arising from the absence of corrective controls on the quality of the seed produced.

In contrast, the information at our disposal suggests that the farmers of the Valley are, by their painstaking methods of cultivation, particularly in weeding and in looking after their seedbeds, well able if trained to produce good quality seed.

For example, in the section farmed in peasant holdings in the M'Pourié area irrigation scheme, the farmers have managed to keep red and rhizome rice under control in a largely-infested area.

We conclude therefore that the production of seedstock (except for hybrid varieties) should be decentralised and entrusted to the farmers themselves. Each scheme, and even every farmer, should produce its, or his, own seedstock, the necessary technique being transmitted through pilot-peasants suitably trained for the purpose.

Seedstock for new irrigation schemes, or stocks of new varieties intended for large-scale dissemination, could be produced by contracting with selected farmers or village schemes with a record of high performance - that of Dieuck, for example. A special extension programme could be set up for the benefit of these producers.

Finally, it would be useful to build up reserve stocks of varieties which have been tested but not used on a large scale, in quantities sufficient to enable quick substitutions to be made in cases of unforeseen and damaging infestation.

6. Supply and stock management

Distribution of these functions between the development corporation and farmers' organisations will vary according to size of irrigation scheme. Supply and stock management on schemes to be developed as "regional growth centres" should be the responsibility of the development corporation, which should service not only the scheme on which the functions will be based, but also the other schemes within the region. The corporation should organise these services on the lines of shops, where the village organisations would make their purchases, delivery being undertaken either by the corporation or by the buyer, at the latter's option.

But resort to these corporation "shops" should be discretionary, the buyers having the option or possibility of going to the private sector. It would be well that the conditions for fixing subsidies and administrative procedures should be the same for both public and private sectors. And the catchment area of each "shop" need not be rigidly defined ; village organisations should be able to go to one or another, irrespective of their geographical location.

Some officially-regulated procedure should be set up to enable the organisations using these services to communicate their complaints and grievances to the corporation's headquarters. On the other hand they should also, before each planting season opens, make known in advance the quantities and delivery dates of the regular inputs they will need for the season.

The principal stocks to be managed by the development corporation's regional shops should be :

- production inputs
- fuel and other consumable supplies for farm machinery
- tools and small gear.

Spare parts for farm machinery should be controlled by the regional mechanical maintenance bases to which we shall refer later ; however, orders for these parts and the stocking of these centres would be best entrusted to the "supply and stock management" shops.

7. Maintenance of irrigation schemes' equipment and infrastructure

We think that maintenance and exploitation functions must be analysed apart, because maintenance is particularly important for the long, and even medium term, stability of every scheme's outputs. And in the past it has been seriously neglected. We are of opinion that one of the most important tasks in the corporation's extension work is to make the farmers and their organisations aware of the maintenance problem. Promoting this awareness should be an element in training programmes at all levels. We see it as divided into three categories :

- maintenance of farming and processing equipment
- maintenance of the irrigation system
- maintenance of irrigation schemes' infrastructure (embankments, roads, tracks).

7.1. Maintenance of equipement

It is our view that the CUMAs should be responsible for maintaining their material after the take-off period of initial cultivation during which specialists and supervisory staff will have been trained by the development corporation, and technical assistance provided for the initial organisation of the CUMA. It will be their job to ensure that the maintenance norms laid down by the development corporation are respected and to decide what maintenance and repair operations they will carry out themselves and what they will refer to the corporation's repair centres, or even to private sector workshops.

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It would be desirable for development corporations to establish repair and maintenance bases at growth centres, and emergency repair workshops on large, and on some medium, irrigation schemes. These bases and workshops would also service smaller schemes, and the centres could be provided with spare sets of equipment for letting out to CUMAs and village schemes whilst their own material is in for repair.

It seems likewise desirable that each centre should enjoy a certain amount of financial autonomy as a means of stimulating them to balance their receipts and costs, but standard rates for the most usual repairs should be fixed by the central administration.

7.2. Maintenance of irrigation network

Every village community should be responsible for this within its own quarter, the development corporation having the duty of overseeing and watching for defective upkeep and applying prescribed penalties (including restoration of the network).

The cleaning out of primary and secondary canals, requiring mechanised equipment should be a matter for the development corporation. But each village organisation could be made responsible for the upkeep and good condition, in an allotted section, of canal edges and embankments (repair of leaks and other fissures, etc ...).

7.3. Maintenance of roads and dykes

Everyday maintenance work should be the responsibility of the village organisations, each for an allotted section, major repairs being undertaken by the development corporation.

8. Management of financial audits and credit

At the level of each irrigation scheme or "perimeter" these duties should be carried out by the chief of perimeter appointed by the corporation with the participation and co-operation of the local intervillage organisation where important decisions and their execution are concerned.

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Each perimeter should have as much financial autonomy as possible ; cultivation and maintenance costs must be balanced by incoming dues and other receipts, and this balance must include provision for building up realistic reserves to cover infrastructure maintenance and renewal of equipment. In this way it will be possible to assess the efficiency of management on each perimeter by comparing the progress of dues received with that of the services provided. Village organisations can make their own comparisons between one perimeter and another, and on the basis of adequate information can take up with the development corporation such questions as the reduction or elimination of certain services, or better costing of others.

In the past, many mishaps in the process of cultivation could not be put right in time by reason of the slow and complicated financial procedures involved. Along with administrative and financial autonomy for irrigation schemes should go a parallel reform of these procedures, without which "autonomy" would be largely meaningless. To substitute retroactive checks for the present out-of-date methods would be more flexible, less costly, and just as effective.

As regards credits, the present system of providing credit to finance production inputs, to be reimbursed at the end of the season, seems to have serious drawbacks amongst which is the growing indebtedness of co-operatives, for which their members feel little responsibility and tend to postpone payment if a crop yield is poor or even mediocre. At the other extreme, the SONADER system of requiring cash down for everything poses difficult cashflow problems for schemes at the start of their operations.

We recommend the study and experiment of a formula for medium term credit with one or two years' grace for repayment, to be accorded to village organisations at the start of cultivation, to provide them with a turnover working fund enabling them to pay for a season's costs. This loan would be repayable over several years, and it would be up to the village organisations to include the annuities in each farmer's assessed dues. The success of such a system will depend on suitably-trained pilot peasants, and on extension staff inculcating during the initial period a proper awareness of the need for financial management.

Similarly, the administration could require village organisations to include in their rules provision for a reserve fund for renewal of their equipment, and major repairs to it ; this could also serve to provide against mishaps and difficulties in the course of production.

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It is our view that during the initial takeoff period on each irrigation scheme, technical assistance should be responsible for making the farmers and co-operative leaders aware of the need to set up reserve funds.

And that this need not be difficult, since on a number of schemes social security funds have already been spontaneously brought into being.

9. Processing and marketing

9.1. Processing of Paddy and marketing of rice

Processing is mainly a matter of milling Paddy. Here again, we are of opinion that a decentralised system in which these activities would be entrusted to the farmers' own organisations would contribute to more efficient operation and be more suited to large-scale development and the promotion of better relations between the development corporation and the population. For example, small village schemes could be provided with small rice mills. It has come to notice that on a number of village perimeters the absence of milling facilities created marketing problems for that part of the crop reserved for the payment of dues, especially in Mauretania where part of the crop is sold as Paddy in Senegal, for want of the means of milling it. It would be worth while to introduce quickly a programme for making small standardised rice mills optionally available.

For the large schemes ricemilling facilities could be provided either at the CUMAs, or at the level of intervillage organisations covering the whole scheme ; both these possibilities should be tried out.

Methods of stocking rice both at peasant-level and CUMA-level should also be experimented.

Marketing functions should be divided between village and intervillage organisations and the government marketing agency. The farmers' organisations would have to decide how much of the crop should be marketed and how much retained for subsistence needs. Sales would be effected directly from producers' organisations to the government marketing agency. The development corporation's role would be limited to mediating when differences arose, and to eventual assistance in the application of certain decisions.

9.2. Marketing of other cereals apart from wheat

Marketing of these cereals would be as for rice.

9.3. Processing and marketing of wheat

The extension of dry season wheat cropping requires a solution of the problem of processing and marketing during the phase of its introduction until a sufficient scale of development has been reached.

As long as production is still very small, marketing in the form of couscous (chiefly in Mauretania) or as grain for despatch to the flourmills (mainly in Senegal) will be very costly. These activities, which should be undertaken by the State marketing agency, will therefore need to be subsidised for some years. This requirement implies that the plan to launch wheat as a crop will have to be carefully prepared, and the economies of production and marketing placed on solid foundations, both from the point of view of production and marketing costs, and from that of the yields to be expected from peasant production.

Experiment and initial propaganda to promote it should aim to reach the threshold of feasibility from which the campaign proper to launch this new crop can begin.

The initial propaganda effort could be made in areas where a local demand for couscous already exists (I).

9.4. Need to promote marketing of millet and sorgho

Finally, with regard to the marketing of cereals in the Middle Valley, we note that there is not only the problem of disposing of irrigated production, but complementary to it that of disposing of traditional cereals forming a main part of the local diet.

Given that both Senegal and Mauretania are deficitary in rice, the development of rice cultivation must long remain a national priority.

And given the agronomic results presently achieved, rice is by far the most advantageous cereal in irrigated conditions. At the present level of irrigated production, the inducement to plant rice is very powerful. Yet, in the Bakel region where the habit of rice consumption is

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(I) Some irrigation schemes in the Rosso region already cultivate wheat and market it locally in the form of couscous.

still very limited, a very evident tendency to substitute maize for rice on irrigation schemes can already be seen. In other parts of the Valley the price of millet can quickly rise to more than double the official price in time of scarcity. And although in the Middle Valley rice consumption is a habit of long standing, there are convincing indications that there is a limit, soon reached, to the elasticity of the substitution of rice for millet and sorgho in daily diet. In Guédé, for example, where most of the farmers have for more than ten years had irrigated plots sufficient for their own subsistence, millet and sorgho still figure largely in consumption, even though the part of rice has substantially increased. The price of millet often equals or exceeds that of rice.

So it is important that steps be taken to make millet available in adequate quantity and at the official price as the extension of irrigation proceeds. This would have the effect of "devaluing" the traditional agriculture of Oualo and Diéré and strengthening the inducement to go in for irrigation. Finally, such a policy would also promote complementarity and exchange of production between regions of rainfed agriculture and those with a vocation for irrigated crops.

9.5. Processing and marketing of tomatoes

Senegal's problems in this field are typically those of an agro-industry supplied by peasant production.

We consider there is a critical need to devise a model contract between growers' organisations and the processing company. It should be worked out under the aegis of the regional administrative authority rather than that of the development corporation. In our view, it should commit the growers' organisations to deliver on their perimeters at fixed dates the quantities requested by the factory, subject to upper and lower tolerance limits. Transport from the pick-up points on each perimeter should be the responsibility of the factory, which is better able than the administration to negotiate transport contracts. Differences arising between growers' organisations and the factory concerning the interpretation of contracts and their execution should be settled by the regional administration. Participation by the State in the capital and on the boards of directors of producer companies should be through its agencies for industrial promotion and the financing of industrial development rather than through agricultural development corporations. The functions of the development corporation so far as tomatoes are concerned should be limited to technical support to growers in production and organisation.

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It would be well worth while to study the possible advantage of setting up a price stabilisation fund which could be used to absorb surplus production in an exceptionally good year, and to provide some subsidies to the processing company for working below capacity in an exceptionally bad year.

10. Functions of the development corporation's headquarters and central office

Freed as much as possible from day-to-day administrative work by this decentralisation, the corporation's headquarters will be able to concentrate to a maximum degree on :

- development planning, follow-up and supervision of how plans (including studies and execution of projects) are being carried out
- training of supervisory staff and specialists
- monitoring of development performance, continuous adaptation and improvement of development institutions and methods
- prospecting for sources of funding, and co-ordination of their projects
- mediating in any differences arising between farmers' organisations and its own services at regional level and on the irrigation schemes themselves.

11. Regulation of land rights, rules for the allocation of irrigated land, and schedule of cultivators' dues and obligations

Verifying traditional land rights prior to site preparation, working out rules for allocation of plots, and assessing the entitlement to plots, are complex inter-related problems involving legal, political, social and economic aspects.

The socio-economic study has endeavoured to provide the basic information needed to enable each State to set up pluridisciplinary working parties to study the land ownership question in relation to the development of irrigated cultivation. We shall confine ourselves here, from the standpoint of development objectives, to putting forward some commencs and reflexions which we recognise to be no more than fragmentary and summary.

From this point of view there appear to be two essential aspects :

- the effect of traditional land ownership on site preparation and on the rules for allocating irrigated plots,

- the influence of this system of allocation on development performance and on its long-term consequences.

It may be well to emphasise that land rights problems vary in acuity between different parts of the Valley. In the Delta and Lower Valley, the works carried out have not given rise to particularly bitter land-rights conflicts. Nor has expropriation to enable site preparation to proceed been responsible for the disparities (not yet very marked) which can be seen on some of the schemes. Those which can be observed are the rather the remnants of the system of allocation adopted at the time when the schemes were initially equipped as flood controlled schemes, or of the co-operative system set up at that time, or again of the conditions in which a flood-controlled scheme had to be promoted (I).

In contrast, at the heart of the Middle Valley, and especially in the Fouta Toro, the ownership of Oualo lands is very strictly observed, and attachment to the land rights system very strong, not only on the part of the owners themselves but also of those with recognised rights of farming granted by the landowners.

These land rights problems are typified by the position at Gorgol and will be found to exist in varying degrees of intensity on all the oualos of the region, even in Senegal despite the existence of the domanial law. That does not mean that the legal framework is of no avail - quite the contrary, it substantially strengthens the Administration's position when disputes arise and have to be resolved. In Mauretania the promulgation of a Law of Agrarian Reform associated, as it might be, with projects for land development, would certainly ease the settlement of land rights questions.

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(I) We refer here to plots allocated to non-cultivators who played a part in the establishment of the scheme or, in the case of Guédé, to the first peasants associated with the pioneer experiment, when intensive irrigated farming was promoted by the Chinese Mission.

As may be seen in the case of Gorgol, the resistance of land-owners cannot block a development project if the government is determined to carry it out. However, it should be pointed out that it is very difficult for the development corporation to speed up the pace of site preparation if it is bogged down from the start on some of the sites by tensions and disputes engendered by land ownership problems. And again, in such a situation it is difficult to promote the formation of farmers' organisations which will not be dominated by the vested interests of a class of the population with little incentive to favour efficient collective management and social justice.

Finally, the traditional structure of land rights may well affect the system for allocating irrigated plots. In our view, the type of solution which would tend to introduce the traditional ownership structure, in whole or in part, into the new dispensation of irrigation, should be avoided.

This brief general survey of the effect of land ownership problems confirms the strategy we have already advocated, ie tackling the sociological aspect simultaneously with the technical feasibility study ; the latter should result according to its findings either in site preparation of the whole project in a single operation, or in a two-phased operation starting with the light clay soils, or in a decision to down-grade the project's priority in time.

As to the system for allocating plots, it has been clearly shown that the method sometimes used by SAED of rotating plot allocations from one year to another does not produce satisfactory results, not only from the point of view of output, but also because from one year to another the condition of the "rotated" plot deteriorates. In contrast, the system of allocation applied on the smaller schemes, carrying an individual (or collective) property right to the plot (or perimeter) tends to produce high performance and a continuous endeavour to improve the land (eg by better levelling).

As we see it, the allocation system should affirm the principle of the cultivator's ownership of his plot, this property right being subject to cancellation in clearly-defined circumstances : the matter in effect is one of establishing the standards on property rights on irrigated land.

We note also the importance of the farmers' contractual charges and obligations which should constitute the contract setting out the commitments to be reciprocally observed between the cultivator, the village and intervillage organisations, and the development corporation.

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Without entering on a substantial analysis of the question, a few examples will illustrate our point :

The contract will determine the quality of maintenance on a scheme. When the responsibilities and obligations of the development corporations and the village organisations have been clearly set out and penalties for lapses by any of the parties concerned have been prescribed, maintenance will be efficiently carried out.

A forfeiture clause for failure to keep plot-levels in proper order can only be applied to a cultivator if he has been able to verify when taking it over that it was in conformity with the standards he was expected to maintain thereafter (particularly in quality of levelling).

The example of the Gorgol contract which made transplanting of seedlings an obligatory part of the process of cultivation is a good illustration of the possibility of using such a contract to promote socio-political aims. In the particular context of Gorgol, this clause has favoured direct owner-cultivators, discouraged non-working proprietors from hiring wage-paid labour to farm their land, and thereby helped to reduce the big landowners' eagerness to hold on to their rights.

In our view, whereas a common general framework for all the irrigation schemes is necessary, it will be desirable to use flexibility in adapting it to the particular conditions and specific objectives aimed at on each project, and in every case to take social restructuring considerations into account equally with the economic objectives.

Penalties and sanctions, as we have already remarked, should be prescribed for non-respect of obligations by any of the parties, whether development corporation, village organisation, or individual farmers. They should be graduated and extreme measures (forfeiture of rights, or replacement of an irrigation scheme leader) should be a matter of last resort. For example, where lapses by the development corporation's services are concerned a scale of reduced charges could be envisaged. And as each scheme is financially autonomous, the scheme leader should recover the abatements by applying to the central office for a grant from a general reserve fund set up for the purpose.

CHAPTER E - IV

CONSTRUCTION AND FARMING COSTS

E. IV.1. Construction costs

1. Monetary costs of construction on small irrigation schemes

2. Construction costs of large schemes

3. Possibilities of reducing construction costs

   3.1. Participation by local population in the work of construction

   3.2. Possible actions to be undertaken to cut the cost of work put out to contractors.

E. IV.2. Farming costs

1. Monetary costs of cultivation on small irrigation schemes

2. Possibilities of cutting down cultivation costs on small schemes

   2.1. Reducing fuel consumption

   2.2. Reducing pump maintenance costs

   2.3. Amortisation costs for motor-pumps

   2.4. Fertiliser costs

   2.5. Conclusions.

3. Cultivation costs on large-scale schemes.

4. Possibilities of cutting down cultivation costs on large schemes.

   4.1. Personnel

   4.2. Seedstock

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4.5. Amortisation of construction costs

4.6. Estimated possible reductions in money costs of cultivation on large schemes.

5. Need to revise pricing policy applied to irrigated cereal crops.

E.IV.3. Farming systems

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3.2. Cultivation by animal traction

3.3. Intermediate mechanisation

3.4. Mechanisation based on medium-sized tractors.

E.IV.4. General conclusions derived from analysis of construction costs and farming costs.

CHAPTER E - IV

CONSTRUCTION AND FARMING COSTS

E - IV.1. Construction costs

1. Monetary cost of construction on small irrigation schemes

This does not pose any serious problems. Mainly it is a matter of the cost (relatively small) of studies, of equipping pumping stations, of a certain amount of masonry work and in some cases of using earth-moving machinery to construct low-level embankments and main irrigation channels. These costs generally add up to between 1500 and 2000 dollars per hectare, the bulk of the work being carried out by village labour.

So far as concerns manual work there would be advantage in experimenting to find out how best navvying work can be done in the specific soil conditions of the valley, and to improve techniques of navvying and compacting, for example by the use of mud (requiring the installation of the pumping station at the beginning of the operation). As water is expensive, losses along the irrigation network should be cut to a minimum, hence the importance of good compacting techniques and of using masonry for selected vulnerable parts of the network.

2. Construction costs on large schemes

These costs vary a good deal from one project to another, moreover, the costing figures in terms of cost per hectare quoted in different reports can vary from single to double and even more.

The fact is that comparison is a tricky business, mainly for the following reasons :

2.1. - The markets for public works cannot be assumed to be stabilised, either in Senegal or Mauretania, and the prices quoted are heavily affected by the local situation at the time when tenders are invited.

In effect, competition between contractors is reduced to those few in number, who have been locally established for a long time, and enjoy in practice a virtual monopoly. Works are put out to tender

piecemeal, as funds are released to finance them. Much greater volumes of work, spread over several years, would be needed to bring in new contractors and ensure optimum use of personnel and material, and thereby the possibility that the prices quoted would be effectively related to the true cost of the work.

2.2 - The stated costs per hectare often represent different services rendered, which makes comparison between them illusory. And the way in which detailed estimates in the contracts are presented contributes to cause confusion since, most times, it does not bring out clearly the individual cost of the different components.

The principal items, which can often be tendered for by contractors of varying sizes and specialities, are usually the following :

- general embanking work.
- irrigation and drainage systems, with accompanying tracks.
- pumping station.
- preparation of individual plots ; clearing of bush, destumping.
- farm buildings and miscellaneous equipment.
- storage buildings and other installations for stocking and processing crops.
- agricultural implements.

2.3 - The estimated cost per hectare depends also on the figure used as "denominator" - ie the irrigated area. These reference figures can differ widely :

- some speak of "gross" area (or "geographical" area)- ie the figure calculated by planimetry from the total embanked area ; this corresponds in general to the figures cited in a preliminary study using the scale I/50,000.

- others refer to the "irrigable" area ; this is the "gross" area less non-irrigable parts of it ; areas of very broken ground, or unsuited by their soil composition to irrigation, permanent ponds and streams. This figure generally derives from a pre-project study and relates to a scale of I/4,000.

SOGREAH studies for 3 pilot sections and 4 perimeters show that in general a reduction coefficient of 30 % should be applied to the "gross" area to obtain the "net irrigable" area. According to whether

the first or the second figure is used, costs per hectare can thus vary by more than 40 % (1/0,7).

Lastly, it should be pointed out that in many projects the outer (general) embankment takes in a much larger area than is prepared for irrigation in the first phase, or over the total "net irrigable" surface within the embanked enclosure, through to the final phase.

And so far as the Delta is concerned it should be borne in mind that the costs do not include the outer embankment, which was built long ago.

2.4 - Furthermore, some estimates include all taxes (TTC) others are nett of tax (HT). The difference was about 50 % in 1973/74 (TTC = 1.5 HT price).

2.5 - Finally, prices can differ from one State to another, from one region to another in the same State.

Some examples of site preparation costs are given in Annexe E.2. Despite variations from one project to another, it must be admitted that taken as a whole costs are high.

3. Possibilities of reducing construction costs

So far mobilisation of financial resources has not proved to be a bottleneck, but as development gathers pace the sums to be invested will become bigger and bigger. For example, to attain an annual rate of development of 5,000 ha. on each bank, this would mean on the Mauretanian side, where present costs are of the order of 2,500,000 CFA per hectare, an annual investment rate of 12.5 milliards CFA, and for Senegal on the basis of 1,500,000 CFA per hectare, annual input of 7.5 milliards CFA.

All these figures are no more than indications of planned or projected costs based on those prevailing today. But they show that hydro-agricultural development is very costly, and that to reduce the volume of investment required a number of measures must be adopted to cut the cost per hectare. These would be as follows :

3.1 - Participation of local population in construction work

Some of the works to be carried out, by reason of their size, quality, or difficulty of execution, can hardly in practice be undertaken except with

mechanical equipment. This is the case, for example, of :

- major embankments surrounding large sections, where the protection of the whole perimeter depends on achieving a high quality of compacting ;

- wide irrigation or drainage channels, and even small or medium-width irrigation channels, where the lie of the land also involves shoring up, and the embankment's length of life will depend on how well it has been compacted ;

- works carried out mainly in reinforced concrete, their proper functioning and durability depending on the quality of the work.

On the other hand, such items, as clearing off bush or even preparing the ground for cultivation, improving levellings, digging out small irrigation or drainage channels, or building small dikes can be very well carried out by the farmers themselves, provided they have been motivated to the need for such work and derive some advantage from their effort by comparison with those who don't share it.

This solution has already been applied on small village schemes, and will enable overall investment costs to be cut.

The SAED/SCET (I) report has taken this hypothesis into consideration for the progressive development of irrigated schemes around each growth center. The difference in overall cost per hectare is : 1.130,000 - 740,000 = 390,000 CFA. We abstain from adopting this figure, as the diminution of certain items (eg agricultural equipment, new villages) has not been accounted for in the report. Instead, we take the difference between the sum of the two items "infrastructure and stations" and "plot-preparation", say 725,000 - 430,000 = 295,000 CFA in 1976 and 340,000 CFA in 1978.

3.2. Possible action to be taken to cut the cost of contracted works

It has already been pointed out that up to this stage as we are still in the period of introducing irrigated farming, development is proceeding by fits

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(I) Programme of short and medium term action for the Senegal River region.

and starts rather than through a steady increase in the rhythm of development, so that the prices quoted in no way reflected economies of scale. And in these circumstances prices were inflated by the costs of mobilising, and demobilising, the equipment and logistic support system, extensive recourse to expatriates instead of training local personnel, and the cost of setting up short-term, provisional arrangements. What is needed now, at the threshold of launching large scale development is to plan a programme of systematic action designed to reduce costs to the extent that economies of scale can be realised.

The principal actions to be taken are :

3.2.1. Grouping of works to be carried out

Undeniably, some conditions in the Valley act as constraints on work-performance :

- high temperatures, reducing the productivity of men and materials, and wearing out the latter more quickly ;

- frequent interruptions of work in the rainy season, and lengthy lay-off in the Oualo during the flood period ;

- movement difficulties, especially during the rains and in time of flood;

- length and difficulty of movement by road (for transport of equipment, building materials, consumable stores, spare parts) from rear base (Dakar, Nouakchott), uncertainty of telecommunications.

Whereas in the course of time some of these constraints can be overcome, particularly those arising from infrastructure (road links, telecommunications, those deriving from climatic conditions are permanent, and one must learn to live with them.

To obviate reductions in human output, acceptable living conditions must be provided. And to combat equipment breakdowns and excessive wear, a maintenance and repair workshop must be established on site. All this is conceivable only in terms of a large volume of work spread over several years.

To ensure that personnel and material are fully employed during the rainy season and floods, a contractor's work programme must be organised

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and grouped so as to enable long stoppages to be avoided ; combining preparatory work on sites not normally flooded with work within areas liable to flooding, construction of roads, buildings, etc ... in short, a programme sufficiently big to include a wide variety of works.

It may be added that only in terms of a programme stretching over several years and of substantial proportions can the contractor be required to exercise proper supervision of the work, and to live permanently at or near the site ; and induced to recruit locally some part of his labour force and train them on the job.

Regrettably, the diversity of funding sources and their separate rules and modes of operation tend to act in the opposite sense. A way to get round this difficulty might be through a revolving fund constituted from different funding sources and at the disposal of the operating agencies (SAED and SONADER). This system would in no way prevent the allocation of particular contributions to particular purposes, thereby " individualising" the input. But it requires a serious effort of co-ordination, and a pipe line of project studies substantial enough to enable a series of irrigation schemes to be grouped, for the purpose of calling for tender. From this point of view, there would be advantage in being able to overleap frontiers and group together works on both sides of the river. This is another stage to be attained, not easily, but perhaps possible under the aegis of the OMVS.

3.2.2. Specialisation of work to be undertaken

Grouping a number of construction projects could eventually lead to a specialisation of contractors, whether by making separate contracts (but this would be a fallback into fragmentation) or by signing a single contract with a team of contractors jointly responsible under the leadership of a main contractor.

In this way, contractors might be identified, specialising in the following branches :

- small and medium embankment work
- reinforced concrete work
- hydraulic installations

- motor-pump groups
- buildings
- etc ...

3.2.3. Encouragement of national (ie "local" - eg Senegalese or Mauretaninan) undertakings

This type of specialisation would enable national firms to be attached to the large contractors, possibly for a start as sub-contractors, but responsible for carrying out works explicitly specified in the contract, and which, benefitting by the experience of their "team-leaders", would gradually hoist themselves up to a level of capability to compete for important contracts.

3.2.4. Financial procedures

As already mentioned elsewhere, a necessary condition for reducing costs is to group together the works to be put out to tender, and announce them well in advance. And another is to ensure steady growth of the works programme rather than progress by jerky increases at intervals.

It follows that negotiations to obtain funding commitments should be started well in advance of the proposed date for beginning the work.

E.IV.2. Farming costs

1. Monetary costs of cultivation on small irrigation schemes

The analysis of these costs made in chapter C.V shows that they are equivalent to I.5 T (tonnes) of rice per hectare in the rainy season. In the off (warm dry) season they are equal to I.9T of rice.This extra cost is due to the cost of irrigation in the dry season, in the first place because water has to be pumped to a much higher level, secondly because loss by evaporation is much greater and there is no gain from rainfall. However, if costs are higher, so are yields, the increases being of the order of from 0.5 T/ha to IT.00 of paddy per hectare. We calculate that at present costs the minimum acceptable yield to keep up the farmers' motivation is 3T.5 per hectare and per crop. At this limit the reward for 300 days'work is equivalent to I.5 - 2.00T of paddy, corresponding to what can be got from flood-recession cultivation in a good year (500 to 200 kg per hectare for 70 days'work). It should also be borne in mind that in present conditions about I/3 of farmers on irrigated land achieve yields of more than 5T and that thereby the

reward for their work is equal to or better than the minimum urban wage (SMIG).

2. Possibilities of cutting down cultivation costs on small schemes

In farming on small schemes the four main cash cost heads are fuel consumption, maintenance, amortisation of motor-pumps, and fertiliser.

2.1. Reducing fuel consumption

The study has brought to light that water supply in general and the organisation of the irrigation rotation system in particular constitute one of the weak spots in the present stage of mastering the techniques of irrigated farming. This can be rectified by the training of pilot-peasants and irrigation wardens (see chapter E.IV) and by the extension programme to be applied during the "take-off" period of farming irrigated land. Improvement of the methods in use to construct and maintain channels and small dikes would also help to cut losses.

We calculate that by these means fuel consumption could in all be cut by 10 %.

As to dry-season irrigation, it may be pointed out that pumping costs will be substantially reduced when the river-flow has been regulated at 300m3/sec. and the level to which water must be pumped thereby considerably lowered.

2.2. Reducing pump maintenance costs

As was stressed in chapter E.I., the present size of village schemes (usually from 10 to 20 ha.) is insufficient to achieve the objective of satisfying the population's basic needs, and involves relatively high pumping costs for the pumping stations.

These costs more than any other item are responsive to economies of scale. The upkeep cost of pumps on FED schemes (see chapter C) are illustrative of costs when projects are small and widely scattered.

Village perimeters should be of the order of 60 to 100 ha if the acreage attributed to each family is to be equivalent to 0.25 ha per adult worker of the family.

This extension of the acreage of village perimeters would also cut maintenance costs considerably, as the number of pumps is the same whether the scheme covers

20 or 100 ha, the only change being in the power of the motor and the volume of water delivered. Maintenance and breakdown repair costs will thus increase only slightly (price of spare parts) when a scheme expands from 20 to 100 ha. The maintenance cost per hectare falls significantly.

Training of pump operators and agricultural mechanics for running repairs would further contribute to reducing maintenance costs.

Finally, as development proceeds, perimeters will become ever closer to each other and the cost of travelling between them (both in time and space) will likewise fall.

2.3. Cost of providing for amortisation of motor-pumps

SAED and the firm of MATFORCE, main supplier of the motor-pumps, provide at present for amortisation over a period of five years. We believe this to be a realistic estimate, on condition that the pump-operators are properly trained to use and maintain them.

A slight reduction in amortisation cost per hectare would be obtained by increasing the power and delivery capacity of the pumps if village irrigation acreage were extended from 10-20 to 60-100 ha.

2.4. Fertiliser costs

The statistics we have produced on production-factor use and yields (ch.III) show that the amounts of fertiliser actually employed by peasants in the Valley are well below the economic optimum and could well be substantially increased. (However, in the calculation of cultivation costs, the figure given relates to the amount prescribed by SAED, which is closer to the optimum).

But it is also worth noting that the higher the input of fertiliser, the greater is the farmers' money risk, and it is only to the extent that the hazards of production are progressively brought under control (mishaps in water supply, seasonal delays, control of plant diseases, pests, predators, etc...) that a higher input of fertiliser can be recommended. For this reason, our suggested solution is to substitute as far as possible natural for chemical fertilisers.

The use of organic manure, largely available throughout the Valley by reason of the substantial amount

of stockraising in every village, should become the target of a systematic propaganda campaign on village irrigation schemes. Already in the region of Matam farmers cultivating maize on irrigated land have begun to introduce organic manure.

But much more promising than the use of animal manure (which in any case is unsuited to the clay soils on the large irrigation schemes) are the interesting results obtained by agronomic research in biological fertilisation by azolline (ferns which fix bacteria as fertilising agents), which in the near future will enable chemical fertiliser inputs to be cut back significantly. It should be possible by effective, systematic extension work to cut the use of chemical fertiliser by 25 % whilst increasing the total dose of fertilisers per hectare.

2.5. Conclusions

If the various steps enumerated above are taken, we estimate that in the context of a new approach to the concept of small perimeters, and of an adequate training programme, farming costs could be cut by about 10%.

3. Cultivation costs on large-scale schemes

These have been analysed in chapter C.V. There is a lack of precision, which should be noted, in the estimate of true farming costs, particularly of the effective cost of different methods of cultivation ; on these matters there are marked divergences between SAED's figures and those in the SICAI report.

Despite these imprecisions, all the estimates concur in showing that the cost of cultivation in money terms is high. One result is that it is not possible to require the farmer to pay for the amortisation of the cost of construction of irrigation schemes (except for renewal of pumping station and mechanical equipment) on the basis of current yields.

4. Possibility of cutting cultivation costs on large-scale schemes

From an analysis of available data, we estimate that reductions can be effected under the following heads :

4.1. Personnel

Taking into account the proposed devolution of administrative functions on the perimeter from the development corporation to the village organisations,

the cutback in staffing after the initial period of cultivation (the costs of close technical support during the first two or three years, and of training of pilot peasants and wardens being accounted for as part of the capital cost of establishing the perimeter), we consider that this item can be cut by 50 % .

4.2. "Seedstock"

This could be supplied by the farmers themselves as suggested in the preceding chapter. This head can thus be eliminated from the calculation of cash costs. It will cost the farmer the equivalent of about 50 to 100 kg/ha (say 2,000 to 3,500 CFA in money terms) to supply these directly.

4.3. "Fertiliser"

Unlike the small schemes located on soils with a small clay content, natural organic manure is poorly absorbed by the heavy clay soils (faux hollaldés and hollaldés) which make up the greater part of the surface of the large schemes, and its use is not recommended. Contrariwise, the techniques of biological fertilisation (azollae) discovered by agronomic research open up very interesting possibilities. We are of opinion that as on the small perimeters, the cost of this item on large schemes could also be cut by 25%.

4.4. Motor fuel and lubricants

The examination made in chapter CV of the figures for traction working times tended to show that by comparison with time spent on cultivation proper, much machine time was taken up in auxiliary operations and in movement.

Similarly, with better upkeep of irrigation channels and improved throughput of water, it would be equally possible to reduce the pumping station's consumption of fuel. On the whole, we estimate that a saving of 25% can be made under this head. And we draw attention to the SICAI report's observation that in irrigated land in Italy the fuel cost per hectare is equivalent to 8,382 CFA compared with 24,000 CFA in the Valley.

4.5. Amortisation of construction costs

As earlier stated, we think it is not possible to saddle the farmers with this charge. Instead, it would be better to make provision for the cost of maintaining the hydraulic network, which we estimate at 10,000 frs/ha for two seasons, say 5,000 frs/ha per season, taking

into account that the tertiary network is looked after by the village communities themselves, who will likewise take part in the control and maintenance of the primary and secondary channels.

4.6. Estimated possible reduction in cash costs of cultivation on large schemes

Taking into account the points and recommended actions listed above, we think it should be possible to cut cultivation costs to near the limit of 92,500 frs per hectare (in June 1979) or about the equivalent of 2.2T of paddy per hectare.

5. Need to revise pricing policy applied to irrigated cereal crops

The analysis of farming costs clearly shows that on irrigated land they will continue to be high in the near future, the more so as relative increases in petroleum prices with their repercussions on the price of fertiliser may also erode any savings otherwise effected in current costs. It would seem to be advisable, in this situation, for governments to consider raising the price of cereals. To align irrigated production in the Valley with world market prices is to place an obvious handicap on its development, and a price adjustment would be justified by the need to achieve food self sufficiency for the country and stable incomes for the population of the Basin.

Similarly, the possibility of harmonising Senegalese and Mauretanian prices should be examined. When the areas under irrigation have been sufficiently extended, crop and fertiliser price disparities may well lead to serious distortions, on both sides of the river. To complete the process, marketing as well as pricing policies could well be harmonised.

E.IV.3. Farming systems

3.1. Methods currently practised in the Valley

As already mentioned, two systems at opposite extremes from each other have so far been almost exclusively practised on irrigated areas in the Valley.

- manual cultivation with primitive implements on small schemes.

- fully-mechanised "dry" cultivation on large-scale perimeters.

If the manual system has proved to be well adapted to the social context of the Valley, it has been possible

only because the plots allocated to farmers have been very small (average acreage per farmer on small perimeters = 0.40ha. cf. annexe CI8).

Statistics of the amounts of time devoted to various operations indicate the need to reduce time spent on the most labour-intensive operations : transplanting (average time 79 days/ha) ; weeding, 67 d/ha ; reaping, 46 d/ha ; threshing, 73 d/ha. (cf. chapter CIV).

As regards large-scale mechanisation, this system in its present use has proved to be socially unsuitable and relatively expensive. The experiment of decentralised management through the establishment of CUMAs (co-operatives for the use of agricultural equipment) should be pressed forward, with an adequate training programme and technical assistance for their initial organisation. Trial should also be made of substituting manual labour for machines for certain operations (reaping), and of developing more efficient equipment and implements for others (threshing).

Whilst improving the efficiency and adaptability of the two systems actually in use it would be well to develop a methodical programme of experiment and pre-extension work on other possible methods of cultivation, in particular :

3.2. Animal traction

Trials undertaken in the Delta and the Bakel region have not given satisfactory results ; but they were not sufficiently methodical to enable firm conclusions to be drawn.

In fact, the programmes were carried out with animals which had not been specially selected, and their feeding was not given proper attention. They were used for ploughing at the end of the dry season and at the beginning of the rains when natural forage is scarce ; in consequence, the animals were undernourished.

In our view, a programme of systematic tests should include a pilot-project for rearing animals selected for draught work, and measures to provide for proper feeding. The ploughing tests should also be made on ground of different degrees of soil moistness.

In any case, farming with draught animals, if it proves to be economically and technically feasible, will only be possible on soils with a light clay content (fondé), ie about one-third of the irrigable areas.

3.3. Intermediate mechanisation

The development of farming methods using intermediate technology - motor-cultivators of I2-20 HP - presents special interest in that they offer the possibility of local manufacture of many of the parts, and are socially adaptable to conditions in the Valley since they involve the grouping of producers into small groups. These machines should be tried out in muddy conditions, as they are not powerful enough to plough dry soil.

3.4. Mechanisation with medium-sized tractors

Medium-powered (40-60 HP) tractors are also unsuited to dry-soil ploughing for want of power. But methods of using them in mud should be tried out ; they could well achieve a substantial economy in fuel, as the clay soils of the Valley, when dry, are very hard to work.

E.IV.4. General conclusions drawn from analysis of construction and farming costs

Despite the possible economies reviewed above, construction and production costs in the Basin will continue to be relatively high, and therefore the improvement of irrigated farming yields is very important. The present distribution of yields is a pointer to the possibility of raising them, since the upper third, geographically distributed throughout the Valley, exceeds 5T/ha. per crop.

This shows how important it is to set up a preliminary training programme prior to the first year of operation of each scheme,and ensure close management and technical support during the first three years of cultivation on each perimeter.

This programme, aiming to improve output and reduce operational costs thereafter, should be treated as an initial investment supplementary to the cost of construction.

Annexe E.I. estimates the total real cost of this programme at 960 dollars/ha. This amount, which is only 7.7-I2.8 % of the investment in construction is likely to raise yields very substantially. And indeed, considering that production costs are high every increase in output constitutes a more-than-proportionate increase in profits.

For example, with current cultivation costs on the large schemes being the equivalent of 2T5 of paddy/ha. an average increase in output from 4 to 5 T, ie an increase of 25 %, would raise the profit by 66 %.

CHAPTER E. V.

TRAINING - RESEARCH AND THE EVALUATION OF DEVELOPMENT IN ITS PERFORMANCES AND SOCIAL IMPACT

E.V.I. - THE RATIONAL ORGANIZATION OF THE ACQUISITION OF TECHNOLOGY

I.1 Assessment of experience to date.

I.2 Need to disseminate the new technology in the local milieu; advantages of an integrated system of training for grassroot extension staff and pilot-peasants.

I.3 Other training needs.

I.4 The complement to preliminary training - by supporting and extension staff to help operational "run-in" during a scheme's first years of cultivation.

E.V.2 - THE INTENSIFICATION OF IRRIGATED AGRICULTURE

2.1 Present dtate of intensification

2.2. The intensification programme before river-flow is regulated.

2.3. The intensification programme after river-flow is regulated.

E.V.3 - THE LINK BETWEEN RESEARCH TRAINING AND DEVELOPMENT

E.V.4 - EMERGENCE OF AN IRRIGATED AGRICULTURAL SYSTEM SPECIFIC TO THE VALLEY

E.V.5 - NEED TO SET UP AN EVALUATION SYSTEM OF EXPERIENCE OBTAINED

E.V.6 - EVALUATION ACTIVITIES

6.1 Continuous ongoing assessment.

6.2 Specific studies and requests.

6.3 Advisory services in support of planning and formulation of activities.

E.V.7 ORGANISATION OF EVALUATION SYSTEM

CHAPTER E.V.

TRAINING - RESEARCH AND THE EVALUATION OF DEVELOPMENT IN ITS PERFORMANCES AND SOCIAL IMPACT

E.V.I - THE RATIONAL ORGANISATION OF THE ACQUISITION OF TECHNOLOGY

1.1 - Assessment of experience to date

The socio-economic study has demonstrated that so far this has been a process in two phases;

- A phase of initiation in the new technology of irrigated farming, previously a totally foreign notion, relying on two vectors, spontaneous spreading of the technology from one perimeter to another, and the work of extension staff. These two are complementary in the sense that where the extension worker is lacking in experience, or motivation, or ability to establish a good relationship with the local people, spontaneous spread of the new technology becomes the determinant. But where the extension worker is experienced, well motivated, and has good local relations, the part played by spontaneous spread dwindles to insignificance.

- A phase we have defined as "appropriation of the technology", during which the farmers' attitude to the new technology changes; from being an alien, external science it becomes a personal acquisition to be mastered and modified by reasoned experiment. In this phase the role of the grass-roots extension worker, and the peasant's willingness to listen to him, both diminish progressively.

The study has also highlighted some weaknesses in the mastering of the new technology; chiefly these are:

- Water supply (waste); irrigation rotations and water control level unsuited to needs.
- operation and maintenance of motor-pump groups.
- work organisation (working times).
- Management techniques.

1.2 - Need to disseminate the new technology in the local milieu;advantages of an integrated system of training of basic extension staff and pilot-peasants

To speed up this acquisition of technology it would be a good thing if the process is conceived as an endogenous one right from the first phase. This means that one has to "seed" technology amongst the farming population at the very time when each new perimeter is brought into cultivation by training pilot-peasants during the year of construction of the scheme as recommended in Chapter IV.

In this way the spontaneous spread of the technology, so far transmitted from one perimeter to another, would begin to work inside each perimeter from the very beginning of irrigated cultivation, thanks to the pilot peasants.

It would be useful as well to reinforce the effect of the two vectors already mentioned by strengthening the links between extension workers and pilot-peasants. This could be attained by shared training.

And as this training must be essentially practical, we propose a system of "total" initiation of pilot-peasants and basic extension staff in the methods, organisation, control and management of irrigated farming, in the conditions in which they are practised on a small perimeter or on a village section in a large irrigation scheme. This could be done by reserving some small perimeters, and some training sections within large schemes, for cultivation by pilot-peasants and extension staff, under the guidance of experienced instructors, for the period of their training, which could be a full year, covering rainy season and cold and hot dry seasons for the pilot-peasants, and two years for the extension staff. During their second year these trainee extension workers will act as group leaders (with duties equivalent to those of pilot-peasants in the initial phase of farming operations on their perimeters).

The organisation of cultivation on perimeters and training sections will scrupulously reflect typical operational conditions on a village scheme or section, from the level of the individual peasant's plot up to that of the co-operative. The organisation of training areas on large-scale schemes must include the establishment of a CUMA (co-operative for the use of agricultural material).

Basic knowledge (of the new methods) should be acquired partly from instructors' explanations in the course of practical initiation, partly in the course of discussion meetings on organization of work simulating those one wishes to promote in every village scheme.

Retribution of pilot-peasants during their training, and of trainee extension workers, should be partly in kind from the product of the crop of each plot in the cultivation of which they take part. An additional incentive could be free supply of the inputs; but it would not be advisable to provide water on a free basis if the notion of economy in its use is to be inculcated.

The instructors responsible for the perimeters allocated to training should all have proved experience in the practice of irrigated farming. On the basis of our own observation we recommend that trainee extension workers be selected in rural areas from candidates who can read, write, and count. And it would be desirable to post them to their own region, but not to their own village, where family ties and social allegiance might impair their performance.

1.3 - Other training needs

For middle grade and senior staff, we suggest that their general professional education should likewise be completed by a training seminar geared to irrigated farming in the specific conditions of the Basin, and also laying stress on the practice of irrigated cultivation.

This training would be of the kind presently dispensed at IRRI, and it might be worth while to consider setting up a common training centre for the whole of the Basin.

Training of irrigation wardens for village organisations could be carried out on the perimeters and sections earmarked for the training of extension staff and pilot-peasants; whilst that of the development corporation's agents responsible for the part of the irrigation network administered by the corporation could be undertaken on a large scheme already under cultivation.

The establishment of a common centre for the training of machinists, pump-operators, and repairers of pumps and agricultural equipment is worth consideration. Insofar as pump repairers on small schemes are concerned, we think it would be a good thing to promote the acquisition of this technique by local persons. The study has shown that in the Valley most artisans are also peasants; when there is vigorous demand for their goods or services they cut down their agricultural activity, and vice versa. It would thus be possible to select men locally for pump breakdown repairs, allocate them an irrigated plot on a village perimeter and allow them credit to buy tools and a stock of the spare parts commonly required. They would also be trained to carry out repairs on outboard motors and vehicles, which would provide them with more constant employment. Once trained and established, they will cultivate their irrigated plots and be available to carry out repairs on neighbouring schemes when so needed. In proportion as the number of schemes increases, they will spend less and less time on their plots and more and more on mechanical repairs, thereby easing the load on the development corporations' regional workshops which would be required only for major repairs. For the management of cooperatives, the training of pilot farmers on the total operations of a village perimeters, already provides each new scheme with persons already familiar with cooperative operations. But we recommend in addition that a cooperative agent be trained for each village before exploitation of its irrigation scheme begins. He would be chosen and recruited by the village, and could receive a stipend from the cooperative as well as an irrigated plot, which could be cultivated by his family.

1.4 - The complement to preliminary training - support by extension staff to help operational "run-in" during a scheme's first years of cultivation

In our view, the seeding of technology by preliminary training should be followed up by a programme of technical assistance during the first three years of exploitation, aiming to prepare the farmers and their institutions so that afterwards they can function autonomously, at a high level of output and with minimum need for intervention by the development corporation.

Specifically, this programme should be devised:

- to consolidate the acquisition of the new techniques by bringing it on from the stage of initiation to that of understanding and sufficient mastery of them to enable the peasants themselves to make the micro-adaptations requisite for their own particular milieu and its evolution, and to apply innovations deriving from the progress of agronomic research.

- to bring work organisation and management to a high pitch, whether at the level of elementary farming operations, or of collective functions and groupings, especially for the management and upkeep of the hydraulic network, of mechanical equipment (CUMA) and the general administration of the perimeter, or village section on a large-scale scheme (co-operatives). Training and technical support during the first three years of cultivation should be considered as initial investments additional to the construction and equipment costs of schemes.

- to organise the peasants and lead them forward to highly-intensive cultivation (see following paragraph).

Annexe E I provides a model for a programme of training and supervised technical support for the three years during which a scheme is brought into operation, together with an estimate of their cost, which should be added to initial investment since their purpose is to bring every scheme up to a standard of high-output autonomous operation. An increased output of 250kg/ha would suffice to amortise these costs over 10 years.

E.V.2 - THE INTENSIFICATION OF IRRIGATED AGRICULTURE

The problem of intensification has two main aspects, which are inter-related:

- intensification before the river-flow is regulated, hence subject to the constraints imposed by the natural flow in the dry season;

- the limits to the area one worker can cultivate in a system of double or triple cropping according to each type of cultivation (manual, light machanisation, heavy mechanical equipment).

2.1 - Present state of intensification

Only the Guédé scheme has so far managed to go in for an annual double crop across the whole of the irrigated area (one in the rainy season, one in the hot dry season)[1]. In the delta and the Lower Valley (as far upstream as Podor) the upreach of salt water during the dry season prevents any attempt at double-cropping.

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[1] Two simultaneous occurrences, the departure of the Chinese technical mission and the diversion of part of Guédé's stock of agricultural machinery and equipment to the Nianga scheme to remedy the situation there, resulted in a drop in the area under cultivation in the 1978 and 1979 seasons.

In the rest of the Valley, the areas cultivated in the cold dry season are still very limited. Wheat production is held back both by the difficulty of disposing the crop and by insufficient local knowledge of how to grow it.

In the region of Matam the growing of maize in the cold dry season is beginning to spread; in this field it would be worth while to strengthen the extension staff's technical knowledge of maize cultivation.

As for agronomic research, there is still need for an intensified programme to develop techniques able to produce sufficiently profitable crops within the brief span of the cold dry season, taking into account the variations from one year to another in the dates of arrival of the first hot weather.

On the perimeters not subject to seasonal salt water upreach, the areas under cultivation in the hot dry season are substantially less than the whole irrigated area. This is due to the constraint imposed by a drop in river-level; the height to which water must be pumped (especially upstream) is so much increased that delivery becomes insufficient to irrigate the whole perimeter.

In the second place, access to water is not always possible when the level of the river (or stream) is at its lowest and especially at the end of the season. So on borderline schemes there is a preference for not planting a crop rather than risk a cut-off of irrigation at the end of the season when a lot has been spent on irrigation up to that point. Although yields (of rice) are higher in the dry season than in the rains, the increase is not enough to offset extra pumping costs, and profits are lower.

Finally, the socio-economic study has brought to light great variations in working times, and this may have an important bearing on the problem of intensification.

In fact, an adequate degree of intensification, on plots large enough to satisfy the farmers' basic needs, can only be achieved with relatively short working times. So it would seem to be important to take up in the near future the question of variation in working times, to determine its causes, which inter alia could be:

- social traditions in the Valley of mutual help, linked with the incidence of underemployment and drought.
- insufficient knowledge of how to organise work.
- the slowness with which the gestures basic to every agricultural operation are executed.
- physical capacity for work, and motivation.

It should be pointed out however that on some perimeters, the different farmers' working times are relatively homogeneous and relatively low, which would tend to show that it is possible both to standardise and reduce these times, if certain conditions are present. It is these conditions which must be identified in the near future.

The programme of experimenting with light mechanisation through the use of intermediate technology, as recommended by agronomic research, should also be pressed forward, along with the development and improvement of animal traction, where soil conditions are suitable (fondés).

2.2. The intensification programme before river-flow is regulated

Before the Manantali and Diama dams are brought into service, the river's natural flow and variations in it set a limit to the irrigated areas cultivated during the cold and the hot dry season.

Areas cultivable during the hot dry season are the most limited, and at present rates of development the limit may be reached in the next two or three years.

Areas cultivable in the cold dry season are less restricted and there seems to be little probability that the limit will be reached by the time the river-flow is regulated, even if development is greatly accelerated.

The aims of the programme during this period are not only to maximise production with the present constraints of water-flow, but also - and even more - to prepare the farmers for a swift transition to a system of optimum intensification on all irrigated surfaces at the time when regularisation of the river-flow will make water available all the year round. Concurrently, this system must be well-adapted to the socio-human context of the Valley, and its institutions.

The pursuit of these three objectives implies that the quota of water available during the hot dry season should be allocated in turn to different perimeters, to enable them to plant a hot dry season crop one year in every two, or three. In this way most of the irrigation schemes will have had experience of the intensive system before the river-flow is regularised. As to the introduction of the "optimum" system, we think that triple cropping on all irrigated areas will only be possible in the medium term on a small number of schemes, exceptionally well organised and cultivated by farmers who are highly motivated; and that constraints imposed by the agricultural calendar will make the combination wet season crop/cold dry season crop just as difficult as triple cropping, from the point of view of organisation and allocation of time (since the time for land preparation and sowing the cold season crop after harvesting the wet season crop is very short).

On this basis it appears that the optimum system to be worked on during the "pre-regularisation" period would be to concentrate on rainy season and hot dry season crops, with possibly a cold dry season crop as a makeweight.

More precisely, this means that on every scheme farmers must be encouraged to cultivate the whole of their irrigated plots during the rainy season, all those which are irrigable during the hot dry season, and whatever they can manage in the cold dry season taking into account constraints imposed by the calendar, organisation and work capacity. This will apply to those years in which a perimeter will be allowed a quota of water in the hot season. In other years, the planting programme will consist of a main crop in the rainy season and a secondary one in the cold dry season.

2.3. The intensification programme after river-flow is regulated

From 1985 onwards in that part of the Valley which will benefit from the Diama dam, and 1986/87 in the remainder, water will be available without restriction throughout the dry season when the Diama and Manantali dams are brought into service.

Since it is also from the beginning of 1985 that pilot-peasants trained in triple-cropping will become available, this opens the phase in which farmers from the start of cultivation on each new scheme can be initiated into a system of two main crops (hot dry season and rainy season) and a supplementary crop in the cold dry season; not only by the action of the pilot-peasants but assisted by close technical support for the first three years.

We estimate that a systematic continuous programme so applied will enable an intensification coefficient close to 2 to be achieved on all schemes which are brought into cultivation after this date.

Later, given progress in working times, and the incentive provided by good yields and the development of mechanisation, this coefficient could exceed 2 by progressive increase in acreage cultivated during the dry season (i.e. through increased triple cropping).

E.V. 3 LIAISON BETWEEN RESEARCH, TRAINING AND DEVELOPMENT

The whole of our analysis so far tends to show that success in launching development on a large scale depends on rapid adaptation of institutions and methods to the specific physical and socio-economic context of the Valley.

Conversely, this adaptation of development institutions and methods can progress quickly only if development reaches a sufficient scale.

This inter-dependence between the pace of development, crop yields and adaptation of institutions and methods brings out the importance of the liaison between research, training and development RTD.

The function of research should not be restricted only to preparing more and more profitable technical packages suited to the physical environment of the Valley, rather it should be broadened to include an integrated improvement of techniques, of farming systems and of training methods, and thus aim at creating a global system capable of rapid extension, and of producing homogeneous high yields in the physical and socio-human conditions of the Valley.

This objective requires that close links be established between Research, Training and Development. In fact, the exploitation of the perimeters and sections reserved for training, and of those cultivated by village organisations or on large scale schemes should be considered as different phases of a vast pre-extension program designed to bring about rapid adaptation and improvement of production systems.

To analyse this liaison we must distinguish between "general applied research" aiming to introduce and improve macro-economic technological innovations corresponding to the Basin's major ecological zones, and the close support research aiming to adapt the results of general applied research on a micro-scale to the specific conditions of individual development projects. But whereas general applied research, which is the responsibility of the National Centres for Agronomic Research, is now well-established, close support research still has to be organised in systematic

fashion and we are of the opinion that this should be done by the development corporations, using their training perimeters as bases and with the indispensable co-operation and support of the National Centres for Agronomic Research.

The organisation of these close support research units on training schemes and sections would enable the direct transfer of consolidated research results to the agents responsible for their local propagation, and create direct links between researchers at different levels; pilot-peasants and extension workers. In this way research would benefit from a network of correspondents across all the schemes under cultivation; this would not only help to spread its findings, but would serve to feed back difficulties in their application, and provide early warning of production problems as they appear and call for corrective action (plant diseases, infestation, pests, etc.). This last point becomes specially important in view of the microbian infestation of varieties of Chinese origin in the region of Guédé, Aéré Lao . . (see Chapter B III).

It must also be emphasised that such close link between Research, Training and Development is equally necessary for the development and extension of systems of light mechanisation using intermediate technology - systems which are important both for intensifying methods of production, with the progressive extension of farmers' plots, and for promoting links between agricultural development and the industrial development it will induce.

At the overall level of the Basin the recent decision to enlarge the OMVS Committee for Agronomic Research into a Committee for Research and Development marks an important strengthening of the liaison between Research and Development. It remains now to establish practical links of assistance and co-operation between the National Research Centres and the development corporations at the level of their research support units on training perimeters which would prepare the way for effective direct links between pilot-peasants, ground-level extension staff, close support research and general applied research.

E.V. 4 THE EMERGENCE OF A FORM OF IRRIGATED AGRICULTURE SPECIFIC TO THE VALLEY

The introduction of irrigated agriculture was, in the beginning, a government initiative aimed at improving production without interferring with the natural flow of the river. This first stage was marked by the introduction of controlled flooding, a technique imported from South-East Asia where river-flow is determined both by the monsoon and by melting snow. It proved to be fairly practicable and economic in the upper reach of the Niger (as far as the interior Delta) on account of the volume of water coming down in the flood-season. But its extension to other river-basins in the Sahel area ended in set-back, since controlled flooding turned out to be as chancy as traditional methods of cultivation, and the benefit of slightly higher yields in a favourable flood season was largely offset by the need for cash inputs, which had to be written off about one year in three.

In the Senegal River Basin the failure of attempts to improve production adapted to the natural river-flow led the states concerned to set up a common organisation (Inter-State Study Committee for the Development of the River Senegal, O.E.R.S. then O.M.V.S.) to study the whole problem and attack it directly by harnessing the river. Alongside these studies and (now) the effort to achieve a regional infrastructure programme, they have launched a programme to introduce irrigated farming with complete water control, in order to establish a basis for a relatively rapid exploitation of water resources when they will become available with the completion of the dams.

The introduction of irrigated farming was thus at the onset of a government-initiated and supported development, using imported concepts and techniques, the maintenance and extension of which at the beginning were essentially due to government supervision and support. The socio-economic study has shown that contrary to what happened in the case of controlled flooding, this initiative by Government has this time triggered the beginnings of a general response throughout the rural milieu of the Valley; and this graft of irrigated agriculture is now showing obvious signs of having "taken", of being absorbed and of expanding.

The social framework pre-conceived by the development corporation to meet the constraints of social organisation imposed by irrigated production is giving way to a process of adaptation of traditional social structures to the socialisation requirements of irrigated cultivation.

Homebred technology is beginning to replace the imported techniques, which it is adapting to the changing requirements of the local milieu.

Successful takeoff into large-scale development now involves a rapid transition from Government-supported to self-supported development in which the government's role will consist mainly in stimulating, supporting and guiding the rapid emergence of a system of intensive irrigated agriculture proper to the rural milieu of the Valley.

E.V. 5 NEED TO SET UP AN EVALUATION SYSTEM OF ONGOING EXPERIENCE

To carry out the role described above, it will not be enough to strengthen the links between Research, Training and Development; it will also be necessary to set up a common system of evaluation of ongoing experience. This in our view will speed up the development of an intensive agricultural system specific to the Valley.

The socio-eocnomic study has sought to provide the basic information to improve working hypotheses for planning the development, selection and formulation of projects in the light of experience gained during the introductory phase of irrigated farming. But a first review and re-adjustment of institutions and methods when only about 10,000 ha [1] have been developed will not suffice to bring about a system of high yield irrigated farming adapted to the specific conditions of the Valley. What is needed is a constant monitoring of performances and the effect of development measures as they are applied on a progressively larger scale.

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[1] This excludes the areas put down to sugar cane by the CSS (Senegal Sugar Corporation), whose methods are of little interest for promoting peasant production in the Valley.

The objective of providing a dependable and improved income to every farmer in the Valley implies a restructuration of income distribution through the development of irrigation, it is thus very important to monitor the social effects of development projects in order to detect income disparities and social imbalances early enough to take corrective measures before these trends become irreversible.

E.V. 6 EVALUATION ACTIVITIES

In our view, the evaluation project should comprise the following activities:

6.1 Continuous ongoing evaluation

The project will include a certain number of continuous assessment activities the methodologies of which have been worked out and tested in the course of carrying out the socio-economic study of the Basin. The principal ones are as follows:

a) Measurement of irrigated farming yields and analysis of their distribution

This was started at the beginning of 1978 by the socio-economic study with the co-operation of the national corporations SAED and SONADER responsible for the development and management of irrigation schemes in Senegal and Mauritania. It consists in selecting, at the beginning of each season, a random sample of about 1,000 plots and using a questionnaire to measure all agronomic and socio-economic inputs (seasonal calendar, working times, water supply, inputs, etc.) on a whole crop season.

At the end of the season, yield is measured on each plot by weighing the product of two square samples.

The data obtained are subsequently fed into the computer to provide:

- correlations between yields and the factors of production,
- statistics on production, working times, costs and returns of different production systems.

In addition to this computerisation, a pluridisciplinary team carries out an inquiry amongst farmers (and groups of farmers where appropriate) with exceptionally high, or low yields.

The purpose of these operations is:

- to provide statistics on irrigated farming
- to provide information on the evolution and distribution of yields
- to analyse the correlations between factors of production (technical, agronomic and socio-economic) and outputs
- to analyse the interplay between socio-economic and agro-technical factors.

b) Observation and follow-up of construction and initial cultivation on small new village schemes

The purpose of this operation is:

- to observe the evolution of working times in construction of small schemes when new techniques and improvements in work-organisation are introduced.

- to study the problems of social organisation encountered in construction and initial exploitation of new schemes.

- to observe the acquiring by the local population of the technology of irrigated farming and the role of supervisory and technical support in this process.

The measurement of construction working times is carried out every year on a sample of projects, carefully selected to take account of their different methods of construction, cultivation, and socio-human environment. Two pluridisciplinary investigations are made, one at the end of the construction phase, the other at the end of the first farming season, to discover what social tensions may have been generated in these two phases. An additional aim is to obtain a better understanding of how the social organisation of a perimeter emerges out of the stresses of its promotion, construction and bringing into cultivation.

Finally, through following up the first season's results by measuring later yields, it will be possible to see how the population is acquiring and mastering the methods of irrigated farming, and to assess the role of supervisory and technical support in this process. This information will be of help in improving training models for extension staff and pilot-peasants.

c) Analysis of construction and cultivation costs for irrigation schemes

This consists of obtaining statistical data on all schemes, and making in-depth inquiries into certain cost items, carried out on a selected sample.

The evolution of construction costs on large schemes will be kept under observation and analysed, to find ways and means of cutting down on the major items.

A cost-analysis system will be devised to enable the computation of the real cost of mechanised operations.

On the smaller schemes particular attention will be paid to maintenance costs and the efficiency of pumping systems.

The efficiency of the different systems of water management will be evaluated.

d) Centralisation of statistical and socio-economic data concerning the Basin

Data collection will focus on the following fields:

- the demographic situation (including migrations)
- agricultural production (farming, fishing, stockraising, forestry).
- the health situation.
- literacy campaigns and education.
- development of secondary and tertiary sectors.
- development of wage-earning employment.
- growth of towns and more generally the process of organisation in the Basin.
- factors affecting variation in working times for irrigated and traditional-style farmings.
- analysis of the process of emigration to the towns of the Basin.
- effects of enclavement on crops produced in the Upper Basin, and on its development.
- etc.

6.2. Ad hoc studies and investigations

These will be programmed as and when the foregoing permanent activities turn up problems requiring further investigation.

Other studies will be undertaken to provide information necessary to plan and formulate certain development projects.

Some important aspects warranting such investigation have already been identified. The principal ones are:

- the changing role of women and children as cultivation is intensified.
- the evolution of land ownership structures, and family and village organisation as irrigated farming is extended.
- motivation affecting the choice of irrigated crops to be planted.

6.3. Advisory support services for planning and project formulation

The common pluridisciplinary evaluation team should be placed at the disposal of the national and regional services to take part in missions and undertake studies relating to the planning of development and the identification and formulation of projects in different sectors.

E.V. 7 ORGANISATION OF THE EVALUATION SYSTEM

Essentially, this is looked upon as a pooling of common experience, which by the diversity of institutions, methods and national experiments contributing to it will be an enrichment for all concerned. It therefore implies that at the base there will be national evaluation activities, or at least provision for collecting the data necessary for the common evaluation programme, to be centralised, processed and analysed at OMVS level. Thus the system would rest on three national evaluation units each with its own programme, and a common programme. These national units would be assisted by a central pluridisciplinary group at OMVS level which would ensure support and co-ordinate the central programme whilst constituting a pool of consultants at the disposal of the national units for the carrying out of their own programmes.

Programming of these activities should be entrusted to a committee representing the three national bodies and the OMVS.

CHAPTER E VI

GEOGRAPHICAL DISTRIBUTION OF IRRIGATION SCHEMES

OUTLINE OF A MASTER PLAN FOR THE FIRST STAGE OF HYDRO-AGRICULTURAL DEVELOPMENTS

E VI - I THE STRATEGIC CHOICES AND THEIR IMPLICATIONS

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CHAPTER E VI

GEOGRAPHICAL DISTRIBUTION OF IRRIGATION SCHEMES

OUTLINE OF A MASTER PLAN FOR THE FIRST STAGE OF HYDRO-AGRICULTURAL DEVELOPMENT

E.VI.1 THE STRATEGIC CHOICES AND THEIR IMPLICATIONS

As was pointed out in Chapter E.II., the extension of irrigated farming has hitherto gone ahead in two separate ways, via large and small irrigation schemes respectively. In the past, no uniform criteria seem to have been applied in selecting sites for large schemes, nor systematic objective unless indiscriminate extension could be so called: By contrast, the small schemes were able to attain the objectives fixed for them for the introductory phase, which were to stimulate local awareness of the benefits of irrigated farming, establish a base for propagating the new technology, and promote the emergence of social forms adapted to irrigated agriculture.

It is now necessary to fix precise quantitative criteria capable of serving as a basis for planning irrigation schemes and ensuring the correct siting and sizing of each future project.

In effect, there are two possible basic strategies:

- either to develop in succession each natural depression, or two or three such forming a polder, basing each decision on technico-economic criteria (ease of access, extent to which infrastructure already exists, topographical and pedological profiles);

- or to subordinate the technico-economic factors to a socio-economic criterion which would consist in allocating to every farmer in the Valley a first plot sufficient to meet his basic needs, and stimulate further irrigated farming development.

If the second of these alternatives is adopted, the geographical distribution of the irrigated areas and the choice of projects will be functions of the distribution of the villages and the size of their agricultural populations.

On the basis both of OMVS's common objectives and of the constraints of development it is in fact clearly the second alternative which must be adopted.

In the first place, from the point of view of providing dependable income for a maximum proportion of the population in all three States, not only does this strategy achieve the first step most quickly, but it will also minimize the risks of emergence of social inequalities, which would surely result from stretching the process of access to irrigated land over a long period, as would have been the case with the first alternative strategy.

Although the socio-economic study has revealed that the structure of land rights ownership in the Valley is fairly rigid, and that these rights are seldom transferred to third parties, we should not underestimate what could happen in a year of drought if one part of the population is privileged by its access to irrigated land whilst another part is totally deprived as a result of climatic misfortune.

In the second place, optimum exploitation of the resources made available by the Manantali Dam, and equitable distribution of them between the three States, require that the need to create an artificial flood should be ended as soon as possible. But under the first of the alternative strategies, this will not be possible, before the last depression in the Valley has been prepared for irrigation, whilst under the second the period will be cut to a minimum.

Nevertheless, it must be admitted that the second strategy will mean concentrating investment in transport and communications infrastructure development much more into the medium term; hence also during the same medium term a bigger effort by way of logistical support on the part of the development corporations.

E. VI. 2 OUTLINE OF A MASTER PLAN FOR A FIRST STAGE IN HYDRO-AGRICULTURAL DEVELOPMENT

On the assumption that the first stage in developing the Valley should aim at providing access to irrigated farming by all those presently engaged in flood-recession cropping, it becomes possible, subject to a number of hypotheses, to draw up a schedule of the irrigation schemes which will have to be developed before artificial flooding can be abandoned.

This is the subject of the report "OUTLINE OF MASTER PLAN FOR FIRST GENERATION OF IRRIGATION SCHEMES (horizon 1990)" published as one of the socio-economic study's special reports (Special Report No. I).

We present below a summary of the process by which the master plan was drawn up, and its overall results.

2.1 The farming population of the Valley

An exhaustive survey was made by ORSTOM (M.A. Lericollais) in 1971-74 of the population engaged in flood-recession cultivation in the Valley, and its findings are in course of publication with the assistance of the socio-economic study.

Amongst other information the survey provides:

- names and location of fields cultivated in flood-recession by each village in each of the main depressions in the Valley;
- a census of the population practising this mode of farming (based on the administrative census of 1970-72), broken down into numbers of families and persons involved on each village field.
- the places where these persons live in the dry season - i.e. in the flood recession season.

The population in question is thus that of the 1970-72 census. Studies made when the report "RHYTHMS OF DEVELOPMENT AND FLOOD MODULATION" (1977) was drawn up have shown that the coefficient of transition from the administrative census of 1970-72 to the detailed census of 1976 was about 1.43(1) which gives a coefficient of about 2.0 from 1970-72 to 1990 on the supposition of a natural increase rate of 2.5% a year from 1977 onwards.

2.2. Surface area per worker

Special report No. I (chap. II, paras.I and 2) describes the process of assessing the amount of irrigated land needed to be allotted for each agricultural worker in order that, in addition to the income he was able to achieve by traditional farming methods in the 1960s, irrigated cultivation will provide enough extra income to make it an attractive proposition.

The finding - within the bracket 0.20 - 0.25 ha/worker - is based on the assumption of a double annual rice crop, with a yield of 4T/ha per crop, and costs estimated at 2T/ha per crop.

The qualitative observations made during the socio-economic study have not, strictly speaking, confirmed this figure; they have simply brought to light on the one hand that the amounts actually allotted on village schemes are nearer 0.10 ha per cultivator, and on the other hand that the peasants regard this as grossly inadequate, and want something like 0.20 to 0.25 ha/worker (say on average 0.75 ha per family).

On the other hand, an attempt has also been made to estimate the minimum or "floor" acreage which should be allotted on a village scheme to enable each farmer to meet his subsistence needs and repay costs incurred (cf. ch. CV of present report).

On the basis of an output of 4T/ha and an "intensity of cultivation" coefficient of 1.50, and taking the figures used in cf. ch. CV for subsistence needs and farming costs, we arrive at a figure of about 0.80 ha for a family of 10 (including 5 workers) or 0.16 ha per worker. The extra acreage represented by 0.20 or 0.25 ha allotted per worker can be regarded as the minimum required to cover basic needs over and above subsistence. This would also represent the minimum acreage from and above which irrigated farming would begin to be sufficiently attractive to allow flood-recession cultivation to be dropped when artificial flood modulation will be terminated.

(1) It is generally recognised that the administrative census systematically under-estimated the population.

2.3. Criteria for site selection of first-phase irrigation schemes

For the siting of these first-phase schemes, two arguments could be considered at the outset:

- either to site them alongside areas of land cultivated for flood-recession crops, since the farmers are accustomed to going there, and the schemes themselves are intended to take over from this flood-recession farming.

- or on the contrary to put them as close as possible to the people's places of habitation, since double-cropping on irrigated land requires continuous care and attention incompatible with living too far away from the perimeter.

It is the second argument which has prevailed, the more so as it is undoubtedly the linking of village with perimeter which has been responsible for the success of existing village schemes.

Naturally, the possibility of siting the perimeter close to the village has its limits, in the shape of constraints amongst which may be cited:

- soil structures; light clay soils (fondé) have been given priority for a number of reasons (easier to work with manual labour, fewer ownership problems than on heavy clays (hollaldé), need to carry on with flood-recession cropping during transitional periods, etc.);

- limits on quantities of water available from the river or its main affluents;

- remoteness of some villages from the river or from irrigable land;

- need to group several villages together in one scheme;

- etc.

2.4. Outline of master plan

This has been set out in three main stages:

2.4.1. Selection of a future year of reference or target year, and detailing on a map the needs of each inhabited place at that date.

The year 1990 has been selected. At the time when the plan was drawn up, it was expected that Manantali would come into operation in 1985 and it was recognised that it would take about 5 years for the people to effect the transition from double mixed cropping (intensive irrigated + flood-recession) to intensive irrigated double cropping.

The coefficient of population increase between 1970 and 1990 being 2.0, and the proportion of economically-active in the total agricultural population being assessed at 0.50, and with a ratio of 0.25 ha per active person, the needs in 1990 for irrigated land could be expressed by a number equivalent to one quarter of the agricultural population in 1970.

2.4.2. Aggregation of every village's needs for irrigated land, calculated on the above hypothesis, and taking into account the positioning of perimeters in relation to both the village locations and to the river and its affluents.

2.4.3. A search on topographical and soil maps on the 1/50.000 scale for large, medium and small perimeter sites best suited to the needs and the location criteria.

The results of this work are presented in the series of maps accompanying the report in annexe.

2.5. Overall results in figures

The overall figures given below relate to the agricultural population engaged in flood-recession farming, to the areas needed, and to the areas proposed by the master plan at the date of the target year 1990.

2.5.1. Population engaged in flood-recession farming (1970).

This is the population taken into account in the ORSTOM survey and enumerated according to inhabited place. But the figures quoted do not, however, include the following districts:

- on the right bank, the departments of Keur Macène and of Rosso (part of the delta), a part of R'Kiz (Lake R'Kiz), part of the department of Kaédi and the Department of Monguel (Gorgol).
- on the left bank, the district of Ross-Béthio (delta).

The Population figures accepted are the following:

- right bank	- upstream (from Bakel to Mbagne)	40 000
	- downstream (from Mbagne to Garak)	77 900
	Total RB	118 500
- left bank	- upstream (from the Falémé to the point of junction of the Doué affluent)	94 700
	- downstream (from the junction of the Doué to Richard-Toll)	92 600
	Total LB	187 300
- Total Valley		305 800

2.5.2. Irrigated areas required in 1990

The figures given represent the net irrigable area (NIA)

- right bank	- upstream	12 500 ha
	- downstream	17 000 ha
	Total RB	29 500 ha
- left bank	- upstream	25 000 ha
	- downstream	21 500 ha
	Total LB	46 500 ha
- Total Valley (net area)		76 000 ha

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2.5.3. Areas proposed in outline master plan

Contrary to the figures given in the preceding paragraph, this does not concern net irrigable area (NIA) but an area intermediate between overall area (OA) and useful agricultural area (UAA), the planimetric measures having been taken on a 1/50 000 scale map after excluding certain non-irrigable areas. It is estimated that the NIA can be obtained by taking 30% off the figures quoted.

- right bank	- upstream	23 500 ha
	- downstream	26 000 ha
	Total RB	49 500 ha
- left bank	- upstream	47 000 ha
	- downstream (down to but excluding Niaga perimeter)	24 000 ha
	Total LB	71 000 ha
- Total Valley (gross acreage)		120 500 ha

E.VI.3 CONCLUSIONS AND RECOMMENDATIONS CONCERNING GEOGRAPHICAL DISTRIBUTION OF IRRIGATION SCHEMES

The foregoing paragraphs have defined the objectives to be attained in order to dispense with artificial flood inodulation and have specified the main criteria used in preparing an outline master plan of the irrigation schemes to be established in a first phase of development of the Valley. In this connection, it may be well be stress two points:

- it is no more than a simple outline, supported no doubt by serious documentary (topographical and pedological) evidence, which makes no claim to be the only solution to the needs of 1990 in terms of irrigation schemes.

- the choice of 1990 is arguable, in the sense that if it can be justified in order to express what is needed to attain a fixed objective (the end of flood inundation) it is too short-term for the planning of large and even medium-size schemes for which 6 to 8 years have to be allowed from the preliminary study to the beginning of exploitation. For these schemes it will therefore be preferable to choose a more distant horizon - for example, 2000 - and limit the amount of irrigated acreage to be developed by 1990 to the needs of 1990.

Master plans are being drawn up on both sides of the river. That for the right bank is nearly completed, and should be available at the end of 1979. On the left bank, the plan has been drawn up in the context of a short draft project covering 50 000 ha and a detailed draft covering 15 000 ha; this plan should also be published at the end of 1979 or during the first quarter of 1980.

These plans will take into account the overriding condition of the need to open up access to irrigated farming to all the populations presently supporting themselves by flood-recession cropping, a condition which has been acknowledged and approved by the OMVS Council of Ministers in the form of the conclusion of the report "Development rhythm and flood control". They will also take account, as the outline master plan did not, of certain objectives embodied in the national plans (sugar production for instance).

But the two plans will have been drawn up separately, each independent of the other. What remains is to harmonise them. This can only be done by the OMVS, in close collaboration with the two bodies responsible for hydro-agricultural development (SAED and SONADER), and will involve more especially the "hydrological" aspect of the plans and the "social" aspect of the development timetable.

As to the hydrological aspect, it will be necessary to ensure that - for example, two perimeters on opposite banks do not hem in the river-flow too closely; this would raise the water level sharply in time of flood, and thus require much more costly embanking. Likewise, the developments envisaged in the master plans will affect the flow of the flood taken as reference, and this will have to be taken into account in calculating embankment levels.

The social aspect concerns chiefly the peasants who live on one side of the river and practise flood-recession farming on the other. One way of avoiding tensions between the inhabitants of one bank and the other consists in promoting irrigation schemes at the same time on both banks where this situation exists; thanks to the ORSTOM survey such places are now well known.

The harmonisation of the master plans could be assumed by a Committee the setting up of which was recently suggested at a meeting between OMVS and funding sources, with the aim of ensuring follow-up of the planning, execution, and operational performances of hydro-agricultural developments. Such a Committee, comprising on the one hand the OMVS and on the other the National Development Corporations, could similarly provide an opportunity to discuss the grouping of studies and development works on both sides of the river, which could favourably affect the speed, and price, at which work is carried out, and facilitate the mobilization of external finance.

E.VI.4 COMPARISON BETWEEN DISTRIBUTIONS OF FARMING POPULATIONS AND OF POTENTIAL IRRIGABLE LAND; PROBLEMS OF LONG-TERM RE-ADJUSTMENT

The outline Master Plan briefly described above shows that the geographical distribution of irrigable land, and of population in the Valley, will enable the whole of the agricultural population to have a first access to irrigated farming, satisfying its basic needs by the period 1990 - 2000, without resort to major population shifts.

We thought it would be a useful exercise to study the possibilities of long-term improvement of farming incomes by increasing the amount of land allocated to each farmer, and of maintaining agricultural employment despite the increase in population, by comparing the potential of irrigable land with the agricultural population.

The comparison has been made on the basis of the results obtained by dividing the irrigable area of every sector in the Valley (18 on the left bank, 19 on the right) by the 1970 agricultural population (ORSTOM figures). According to the hypotheses adopted in drafting the outline master plan, the figures in question represent what will in 1990 be the net potentially irrigable area per agricultural worker.

The area per head varies between 0.40 ha/worker and 3.65 ha/worker, the average for the Valley being about 1.15 ha/worker.

The most poorly-endowed sectors are:

Right bank:
- Lake R'Kiz (0.40 ha/worker for a NIA of 8 000 ha.
- The region between Boghé and Bababé (0.40 to 0.45 ha/worker.
- The Gorgol valley (0.40 ha/worker)
- The Maghama sector (0.65 ha/worker).

Left bank:
- The Dagana sector (0.95 ha/worker, and even less if the M'Pilor basin is used to produce sugar cane.
- The Saldé-Horé Fondé sector (0.75 to 0.90 ha/worker).

Sectors such as these will be fairly quickly saturated, whereas others, often fairly close, will take much longer.

These figures show that beyond the year 2000 the prospect of improving farm incomes and maintaining agricultural employment by expanding the development of irrigable land will continue to exist, but certain sectors will be saturated and it will be necessary to adopt a policy of relieving pressure on them by migration to neighbouring areas where the ratio irrigable land/agricultural population is more favourable.

These irrigable land/population ratios do in fact show that it is also possible to allocate irrigated plots to agricultural inhabitants of regions situated away from the minor bed of the river (strata two and three of our population listings) and by this means to give them direct access to irrigated farming, thus preventing their home areas from becoming mere labour reserves for the farmers of the Valley.

However, in view of existing land rights, we do not think it will be feasible to establish these populations on irrigated land until those who are now practising flood-recession farming have already been given a plot sufficient to meet their basic needs.

The foregoing considerations demonstrate by way of supplementary argument the advantage, and even the necessity, of a strategy aiming to provide as quickly as possible initial access to irrigated cultivation for the whole of the agricultural population at present dependent on flood-recession cropping.

The question of the rhythm and speed of development, of yields and geographical distribution of irrigation schemes, should not be seen simply from the angle of economic returns and of justifying investment in an infrastructure programme for regularising the river-flow; more important still is the fact that it conditions the social restructuring necessary to ensure stabilised incomes for the population of the Valley and adjoining areas.

CHAPTER E. VII

PLANNING THE DEVELOPMENT OF IRRIGATED FARMING

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E.VII.6. - THE PLANNING OF THE PHASE OF LARGE-SCALE DEVELOPMENT

CHAPTER E.VII

PLANNING THE DEVELOPMENT OF IRRIGATED FARMING

E.VII.1 INTRODUCTION

In earlier chapters we have examined the measures needed to increase the pace of development, improve yields, and provide for the whole of the agricultural population a first plot of irrigated land sufficient to meet basic needs, and enabling artificial flooding to be terminated.

We have now to consider the conditions which the planning system has to meet in order to realise them in a consistent and efficient manner, and to fix realistic quantitative objectives to be attained, in terms of pace of construction and of total irrigated acreage.

E.VII.2 THE PLANNING HORIZON

In endeavouring to set a date for a medium-term planning horizon, two considerations come to mind, the first the date when the dams will be completed and water will be available all the year round, the second the date when the whole of the population now engaged in flood-recession farming will have an initial allocation of irrigated land. This would also correspond with the time when artificial flooding could be ended.

There are however serious objections to determining the planning horizon by the date of completion of the dams.

In the first place, this date being around 1985 is too near. Every agricultural development presupposes a social restructuring without which it would not be self-sustaining. An agricultural plan limited to a 5-year period would in our view be illusory, since it cannot pursue these social restructuring objectives.

Secondly, it must be borne in mind that the availability of water through a regularised river flow conditions all development in the Valley, but it is only from the time when water is available that it will be possible to begin to develop methods of exploiting these resources effectively. We think four or five years after the dams are completed will be needed to enable the regularised river flow to bear fruit, i.e. for the annual one-crop system to be replaced by double-cropping on the whole of the areas prepared for irrigation at the time when river flow is regularised. Finally, the date when the dams will be completed leads us to put the planning period at about 10 years and the planning horizon at 1990.

The important point is to know whether this horizon - which meets the concern for an economic return from regularisation of the river-flow - will also correspond to the social objective of a first stage in stabilising and guaranteeing farm incomes in the Valley.

One of the essential aims of medium-term planning, as we see it would be to make these two horizons coincide; this means developing in 10 years about 70 000 ha, geographically distributed along and across the whole of the Valley (1).

Allowing an interval of three or four years this would also correspond to the development hypotheses adopted by the Global Evaluation Report for calculating the economic return on investment in regional infrastructure works.

E.VII.3 THE STRATEGY OF IRRIGATION AND ITS PHASING

The results of the socio-economic study tend to suggest that take-off into larger-scale development is essentially a matter of rapid transition from a government sustained process, inevitable during the initial period introducing irrigated farming, to a self-sustaining process in which production control and management will be essentially matters for the peasants themselves and their organisations, with Government's role becoming mainly one of co-ordination and guidance, and of logistic and technical support to the efforts of the people themselves. Only in matters of infrastructure will development remain under the chief responsibility of the State.

This transition amounts to a veritable restructuring of the development process, now feasible because all the evidence collected indicates that the population has risen to the Government's challenge in introducing irrigated farming and is capable of mastering its techniques sufficiently to achieve generally satisfactory yields, and of organising itself at village level to take proper care of the collective functions and discipline required to manage a village scheme or a village sector on a larger scheme. These two capacities are indispensable for the establishment of an overall development structure resting on popular institutions mobilised and coordinated by governmental action.

But we have seen that this restructuring requires:

- A rethinking of irrigation scheme concepts.
- A redistribution of functions between the development corporation and the people's organisations (this implies a re-organisation of the development corporations)
- Continuous experimentation and improvement of farming methods so as to adapt them not only to agronomic but also to social requirements.
- A training and extension programme well suited to the development strategy and in particular to the distribution of functions and the conception of irrigation schemes.
- A reinforcement of research-training-development links.
- The establishment of a system to evaluate performance and the social impact of development.

(1) These 70 000 ha are additional to the 23 000 ha already developed at end-July 1979.

Granted that restructuring is necessary to promote development on a large scale with adequate guarantees of an economic return, i.e. of high yields, irrigation development strategy must comprise two phases.

- A first, transitional phase which will serve to effect all the institutional changes, and assemble all the factors, needed before take-off into large-scale development can begin.

- A second phase, of large-scale development, in which these institutions and factors will be utilised to attain the planned rate of development, and to exploit as soon as they become available the water resources brought into service by the completion of the dams. By this means the objective of initial access by the whole of the population to irrigated farming (100 000 ha prepared for irrigation) should be attained as well as that of general extension of dry-season cropping - both cold and hot dry-season - when water will become available year-round, thus reaching an intensification coefficient close to 2, with homogeneous, regular and high yields.

E.VII. 4 PLANNING THE PREPARATORY PHASE FOR THE LAUNCHING OF LARGE-SCALE DEVELOPMENT

4.1. Priorities

During this period priority must be given to the pre-investment programme which will have to prepare the human resources, institutions, methods and studies necessary to sustain the annual rate of development adopted as the objective to be attained at the beginning of the phase of large-scale development.

In this preparatory period the programme for extending irrigated areas will have to take second place to pre-investment objectives. This means, in other words, that the annual rate of irrigation development must only increase to the extent that it does not occur at the expense of the allocation of human resources and institutional capacity required to carry out the pre-investment programme.

Also to be taken into account is the need to consolidate irrigated areas already under cultivation, more especially since the reforms involved by consolidation should give us useful indications on the kind of institutions which large-scale development will need. On this account, it seems that any increase in the rate of development in Mauritania should proceed cautiously, and that in Senegal it might even be advisable to slow down the execution of some projects to enable more attention to be given to consolidating the management of areas already under cultivation.

4.2. Objectives and Duration of Preparatory Phase

In this preparatory period the essential, and also the most delicate, question for planning is to decide on the objectives and the time needed to reach them. Clearly, one should aim to achieve the highest possible development capacity in the shortest possible time. But this objective should be tackled realistically, otherwise the planning process would lose its efficacity, being no longer able to bring together the required conditions for take-off in the ensuing period. A careful appreciation of the constraints is all the more necessary since the effects of under-capacity of the overall management system will make themselves felt only after a certain time-lag. The need to be ambitious and yet realist can be reconciled by carefully selecting the objectives and simultaneously setting up a planning system allowing enough flexibility through continuous feedback and adjustment based on efficient monitoring of development performance. The aspects concerning the planning system will be dealt with later.

As to the objective of development capacity to be attained in the ensuing phase of large-scale operations, we incline to think on the basis of the results of the socio-economic study that a development rate of the order of 10 000 ha annually, as recommended by the global evaluation report, is both desirable (not to say essential) and attainable. And we believe that four years will be needed to make its achievement possible.

The global evaluation report has recommended this rhythm of development on considerations of cost benefit analysis. We would like to point out that this capacity is also necessary to achieve the social objectives adopted by the OMVS since providing a first access to irrigated farming to the whole population in the shortest period of time is a must for further accelerated development without generating pronounced social disparities. We should remember too that in the long run development of the Basin is a race against the clock with population growth, especially if the need to reduce emigration is taken into account. And the rapid creation of an adequate base for agricultural production and incomes will condition the later development of secondary and tertiary sectors which along with agricultural expansion will ensure full employment and the take-off of regional development.

To judge the feasibility of the capacity objective and the proposed four-year period to attain it, we must examine the pre-investment programme and assess the extent to which the timetable for carrying out each of its components is realistic.

E.VII.5 THE PRE-INVESTMENT PROGRAMME FOR THE PREPARATORY PHASE

By pre-investment programme we mean the whole of the interlocking actions aiming to bring together all the factors and information needed to obtain an annual development capacity of 10 000 ha by the beginning of 1985.

On the basis of the analysis of the factors affecting the rates of development and the yields which was made in the preceding chapters, this programme should include the following main components:

5.1. Development of a new concept of irrigation schemes

5.1.1. The Dombo Thiago and Boghé projects

As already mentioned, the Dombo Thiago project in Senegal and Boghé project in Mauritania now being executed represent the beginning of a second generation of large and medium-size schemes in which past experience has been used to adapt strictly physical notions of development to the constraints imposed by the social organisation of production specific to the local milieu.

Similarly, the underlying concept behind these projects as well as the methods of construction introduced take care of the need to combine contractors' operations with those to be carried out with village labour.

5.1.2. Preparation of a guide to rivise ongoing studies and to draw up new feasibility and construction studies

A pluridisciplinary working group (OVSTM-SAED-SONADER-OMVS) making use of the information provided by the Dombo Thiago and Boghé projects, the socio-economic study and the master plans which are in the process of finalization on both sides of the river, could be set up to develop models serving as a guide to correct existing studies where necessary, and in initiating new ones.

This guide would specify:

- The sociological investigations and promotional actions to be undertaken within the context of the pre-feasibility studies.

- The criteria and norms to be used to decide the extent and location of the areas to be allocated to villages (taking into account their agricultural population and the forms of social organisation proposed by the village communities with the help of the development corporation.

- The layout of the irrigation network, taking into account the results of the above investigations as well as pedological and topographical data.

- The delimitation and co-ordination of the works to be carried out by contractors and those to be undertaken by the local people (including standards of plot-levelling by machine, and its subsequent finishing-off by hand).

- The other activities connected with irrigated farming and concerned with production and conservation (re-afforestation, stock-raising, fish-farming).

- Housing problems and the possible need to relocate certain hamlets and villages.

- For small perimeters, the different types of village irrigation scheme which can be developed, it being understood that they should cover areas of 75/150 hectares (depending on whether they are, or are not, embanked); and definition of the guide lines which should determine their conception and construction standards.

5.2. Constitution of a studies portfolio sufficient to enable construction work to attain an annual rate of 10 000 hectares by January 1983

5.2.1. Studies portfolio for construction of large irrigation schemes

In order to be able to bring irrigated land into cultivation at an annual rate of 10 000 ha from 1985 it will be necessary to undertake construction at an annual rate of 10 000 ha of net irrigable land from the beginning of 1983, since it takes two years to complete a large or medium-size perimeter. It should also be borne in mind that each year a proportion of the 10 000 ha will be in the form of small schemes (and the proportion should be relatively high in the opening years so far as the availability of suitable sites permits) and that these require only one year for development.

As was noted in Chapter E.III, to cut down construction costs on large perimeters it is better to group contracts put out to tender and spread their execution over several years. This being so, and if out of 10 000 ha between 5 000 and 7 000 ha are to be developed each year as large schemes, each grouped contract for which tenders are invited should comprise about 20 000 ha. The construction studies portfolio should therefore cover about 25 000 ha, and the feasibility portfolio 30 000 - 40 000 hectares.

The present position relating to different categories (set out in Annexe E.3. (1) can be summed up as follows:

- 116 000 ha (SAED - 40 000 ha, SONADER - 71 000 ha) of "identification" projects, financed to the extent of 54%.

- 55 175 ha (SAED 17 975, SONADER 37 200) of feasibility study projects (draft project summary) and construction studies, likewise financed to the extent of 54%.

- 17 295 ha of projects being carried out, financed to the extent of 94%.

(1) Annexe E.3. is an extract from OMVS document ER/HC/18-79 "Note on Rural Development in the Basin of the Senegal River", jointly prepared by SAED, SONADER and OMVS.

The present situation shows that it is possible to complete the construction studies and invite tenders for the preparation of 10 000 ha in 1983, and to build up a further portfolio of construction studies covering 25 000 ha in time for 1985. We believe that the works to be executed in 1983 and 1984 can fit into the new irrigation scheme concepts, but they will only partially conform to the geographical distribution necessary to provide a first plot of farming to the whole population, and this will involve some delay in achieving the first stage of securing dependable farm incomes.

5.2.2. Reinforcement of capacity to undertake studies for small irrigation schemes, and carry them out

As regards the capacity to carry out studies, supervise the work to be undertaken by the village communities, and equip pumping stations on small schemes, we estimate that at present it is about 200 ha/year in Mauritania, and 1 000 ha/year in Senegal. But this capacity has so far been related to perimeters generally between 15 and 30 hectares. In the future, we have accepted that the small schemes to be developed by these methods will be between 75 and 150 hectares.

Again, it is envisaged that irrigation schemes grouping two or three villages and covering areas of the order of 150/300 hectares will be studies and constructed with the same methods and organisation as those employed for village schemes.

As the size of each perimeter will be larger than in the past, each planning team would be able to draw up plans and supervise their execution on greater overall acreage.

To obtain some idea of the number of personnel required, we could use the following working hypotheses:

- an area of 2.500 ha on each side of the river represents the annual preparation of 25 schemes averaging 100 ha each, and to carry them out each development corporation would need;

- 3 planning teams (one team for 6 or 7 schemes), each comprising:

  - 1 foreman for civil works
  - 1 topographer
  - 1 assistant topographer
  - + labourers.

- 3 teams of pump fitters comprising:

  - 1 fitter-mechanic
  - 1 assistant mechanic
  - + labourers.

These teams will be led by 3 qualified irrigation engineers.

On this basis, we estimate that the necessary personnel can be recruited and trained by the end of 1983, on the understanding that external technical assistance may be sought to provide the 3 irrigation engineers.

5.2.3. Reinforcement of capacity to undertake sociological studies and promotional action

An important innovation in the new concept of feasibility and operational studies is the integration of the sociological constraints specific to each local milieu along with the technico-economic considerations when projects are being worked out. It seems to us absolutely indispensable that the development corporations should be equipped to identify and take account of these constraints, rather than sub-contracting these tasks to alien contractors, whose consultants cannot possibly have the in-depth knowledge of the milieu and of previous social experiments which a permanent evaluation unit of SAED or SONADER will accumulate, with the back-stopping of an OMVS team. We estimate that starting with the existing evaluation teams in OMVS, SAED and SONADER, it will be possible within two years to train the four to six additional economists necessary to carry out sociological studies and follow-up covering 5 000 ha of large schemes and 5000 ha of small schemes (where the need for such work is much smaller, and more marginal, than on the big perimeters).

5.3. Shaping the institutional organisation of development

The hypotheses worked out on the basis of the socio-economic study's findings can be tested and assessed for revision by feedback from the following operations:

- The system of continuous evaluation of performance and of the social impact of development, as a follow-on to the work of the present socio-economic study, should become operational in the second half of 1980. It will provide data for ongoing adaptation and improvement of existing institutions and methods, from June 1981.

- The starting of cultivation on the Dombo-Thiago scheme in 1980 and at Boghé in 1981. How this is organised will serve as a pilot-experience for shaping the institutions and methods to be brought into use when large-scale development reaches its "launching-period" at the beginning of 1985.

- The re-organisation and decentralisation of functions on the SAED's existing large schemes, which has already started in the Delta and should be completed in 1982. This should supply valuable information on the organisation of co-operatives of interco-operative groupings, and of managerial functions within the development corporations.

  Improvement of management and farming methods on existing small village schemes will go on continuously with the application of the training and supervisory/extension methods planned for the launching of large-scale development. (See Annexe E.1.). Since these schemes are to be enlarged from their present sizes (15-30 ha) into schemes covering 75-150 ha, improvement will be effected via the starting of cultivation of the additional acreages.

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We are of the opinion that by this means the institutions and methods developed as a result of systematic evaluation of experience over the past 10 years will have been tested sufficiently to enable large-scale development to be pursued in and from the year 1985.

5.4. Reinforcement of the institutional framework of the development corporations (SAED and SONADER)

Three separate programmes of institutional development call for consideration:

- The reinforcement of central and regional management functions (those concerned with the study and construction of perimeters have already been reviewed);
- Reinforcement of the regional logistic support system and supply functions;
- The development of the training and extension support functions in the initial phase of cultivation, necessary to enable each scheme to function autonomously (with the help of the logistic support system);

Development of the planning system will be separately considered later, as it involves a regional level (OMVS) and national levels.

5.4.1. Reinforcement of central and regional management functions

It may be noted that these functions will be much less burdensome in the context of a decentralised management system relying on maximum operational autonomy of each irrigation scheme. But the investigation already conducted into the organisation of SAED and SONADER could well be reviewed now in the light of the new concepts of irrigation schemes, and of the adoption of an overall management system capable of rapid expansion, such as we have recommended.

In SAED, the reform of present structures with its consequent redeployment of personnel raises delicate transitional problems. And in these circumstances we wonder if it would not be best to concentrate on these structural reforms at regional and central levels for the next four years, and to spread the reorganisation of the administration and cultivation of existing schemes, if necessary, over a longer period.

This would have the advantage of establishing a support base adequate to take care of the new projects coming into operation, and a coherent system into which existing schemes could be progressively fitted.

For SONADER, institutional development can in our view continue at the same rate (in terms of expansion of personnel), the accent being put on regional functions and improved integration of its development and managerial activities on large and small perimeters.

5.4.2. Reinforcement of regional logistic support system and supply functions

This is a matter of setting up three or four regional centres for major repair and maintenance functions (see Chap. E.II.) and a similar number of supply stores for production inputs.

Spare parts for pumps and agricultural machinery can be sold to irrigation scheme workshops, or to the established mechanics, either by the workshop or the supply store.

The supply and control of store and workshop stocks will be the responsibility of central services.

This programme can, in our view, be realised in four years (three for planning, equipment, supply, construction of buildings, recruitment, etc. of personnel, and one for initial organisation and operational running-in).

5.4.3. The training and extension support programme for the initial cultivation period

This programme, which aims to bring each scheme after three years of cultivation to a degree of autonomy reducing the need for subsequent support to a minimum whilst ensuring adequate yields, is to our mind the crucial factor in the attainment of a high rate of development, and for this reason we have provided in Annexe E.1. a draft project and cost-estimate for such a programme.

The cost- less than $1000 per hectare - should be treated as an initial investment to be added to net construction costs. An increased output of 250/kg/ha per crop would suffice to amortise it over ten years.

The planning could be as follows:

Project for training pilot-peasants

- establishment and equipping perimeters reserves for training: 1980/end-1982
- recruitment of trainers and refresher courses: 1980/end-1982.
- training begins: January 1983.
- first batch of pilot-peasants complete their training: December 1983.
- first batch of basic extension staff complete their training (2 years): December 1984.

Project for training irrigation wardens - same timetable as for pilot-peasants.

Project for training tractor drivers, pump operators and mechanics

(pump breakdown mechanics for small schemes, maintenance mechanics for CUMAs)

- establishment of training centres and recruitment of training personnel: 1980 to December 1983.
- opening of training centres: January 1984.

Other training activities - in the shape of scholarships and training courses would be spread over the years 1983 and 1984.

The summary below sets out the total of qualified personnel needed to attain a development capacity of 10 000 ha; it is extracted from Annexe E.1.

Summary of qualified personnel needed for a development capacity of 10 000 ha/year:

Expatriate experts

For training

- 8 extension agronomists to train pilot-peasants
- 1 mechanic to train pump operators
- 1 irrigator to train irrigation wardens
- 1 manager to train co-operative officials
- 1 agricultural machine engineer to supervise the training of tractor drivers.

Technical support for initiation into irrigated farming

- 10 agronomists for extension work
- 5 irrigation engineers
- 5 agricultural machinery engineers
- 5 co-operatives management experts

Total expatriates: 37

Local experts

For training

- 40 trainers for pilot-peasants (recruited from present monitors + 6-months' training at ADRAO, or on-the-job course).
- 6 mechanic instructors for pump-operator training centre (State vocational school diploma + 6 months' scholarship course).
- 4 pumping-station mechanics (vocational school diploma + 6 months courses on a pumping station).
- 4 training cadres for irrigation wardens (technical field officers (I.T.A.) or foremen + 6 months training abroad).
- 4 mechanics for small-scheme pump-repair workshops (vocational school diploma, training at pump operator training centre).
- 2 experts in co-operative training (ENEA diploma in Senegal or CFVA in Mauritania + 6 months training abroad).
- 8 instructors for tractor driver training centre (vocational school diploma + 6 months training abroad).

Technical support for initiation into irrigated farming

- 20 agronomists for extension work (agronomist engineers + 12 months' training at ADRAO or IRRI).
- 10 irrigation engineers (irrigation or public works engineers; + 12 months' training abroad).
- 10 agricultural machinery experts (mechanical engineers + 12 months' training abroad).

Total of local cadre needs

- Senior cadres: 30
- Senior/middle grade cadres: 26
- Basic grades (monitors) 40
- Vocational cadres (mechanics) 27

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Annual qualified-personnel needs for ongoing technical support after first three years of cultivation on each perimeter

After these first three years (i.e. from 1988) only local qualified personnel will be needed:

- 5 agronomists for extension work (selected from those with 3 years' experience in technical support of initial cultivation),
- 10 technical field officers (medium-grade cadres),
- 8 mechanics (for pumping stations and small-scheme pump-repair workshops).

OBSERVATION

Personnel engaged in the administration and maintenance of primary and secondary irrigation networks on large perimeters are not included in the foregoing list.

We believe that this number of personnel can be both recruited and managed.

In particular, in the category of personnel classed as "local" it may be pointed out that the average annual cost allowed for each expert ($20,000) will enable a proportion of non-nationals from other OMVS or African countries to be recruited, and that one-year further training scholarships are to be provided for all local personnel.

5.5. Reinforcement of planning system

At the present time the Master Plans for the right and left banks are being drafted. The work has been put out by SAED and SONADER to sub-contracting firms who are making substantial use of the socio-economic study and the draft Master Plan prepared by OMVS which serves as a guide to the geographical distribution of irrigation schemes.

These studies are to be completed by the end of 1980 and will serve as a guide for the establishment of perimeters up to 1990/95. In our view, they will constitute the basic documentation for future planning.

They will need to be revised and completed; first of all to ensure that development on the two sides of the river is harmonised (the technical and socio-economic reasons for this have been explained in Ch.E.VI.); secondly to ensure their correspondence with the pre-investment programme to be prepared on the lines we have broadly sketched out.

But although the production of a well-articulated and complete plan is important, the really essential component of the pre-investment programme appear to be the setting up of a planning machinery capable of controlling the preparation and the launching of large-scale development, along with training and supervisory/technical support for the initial phase of cultivation on irrigated land.

Mastery of the problems involved in development take-off, and continuous adaptation and improvement of its institutions and methods, require a planning system not merely designed as a static structure for preparing a common Master Plan covering the whole Basin, but devised as a system of continuous management and adjustment of the Plan and of guidance in its execution, in the light of constant feed-back on performance, and assessment of it.

Two seemingly contradictory constraints have to be reckoned with in working out planning structures:

a) the need for an efficient operational system, hence for the simplest possible structure for the initial preparation of the Plan and the follow-up and revision of its execution;

b) the inevitable complexity of the decision-taking bodies arising from inter-State co-operation in the development of the Basin, and the necessary existence of the following main organs:

- The National Committees for Development of the Basin, which have to ensure consistency between the River Basin Development and each national development, and within the Basin between agricultural development and that of other sectors.

- The organs of decision in OMVS (Conference of Heads of State, Council of Ministers and the committees emanating from it) which have to decide on Basin development objectives and common policy.

- The national development corporations SONADER, SAED, OVSTM responsible for developing irrigated farming in the Basin.

To reconcile these two constraints it is necessary to distinguish the operational process of planning which includes preparation of the draft plan and programme and their execution which should be the responsibility of the national development corporations and their co-ordinating body the High Commission of the OMVS, from the decision-taking and control process which should be distributed between the National Planning Committees (for national planning) and the appropriate organs of OMVS (for regional policy).

In this perspective, the planning procedure would be as follows:

The preliminary drafting of the National Master Plans would be concerted by the National Development Corporations, with the OMVS acting as the harmonising link.

The proposed master plans for the agricultural sector will have to include the development programme proposals of other sectors of activity, within the Basin and even at national level which are necessary to support the River Basin development. They must therefore take account both of the guidelines set for the national plans, and of the common objectives and strategy of Basin Development. This should not cause any major problem of arbitration since national and regional development strategies are complementary.

These draft Master Plans (which are already harmonised by consultation between the three development corporations) will be examined and finalised by the National Planning Committees.

They will similarly be scrutinised by the OMVS Council of Ministers in which the National Committees are represented and proposals of modification by each National Committee can be harmonised and adopted.

At the same time and on the basis of the national plans the OMVS will have prepared a draft overall Master Plan; this will include regional and national projects, and will be amended as decided by the Council of Ministers.

The management of these Regional and National Plans should be delegated to the National Development Corporations (for execution of the national plans) and to the OMVS (for regional projects and the co-ordination of national programmes). Necessary adjustments will be effected as a continuing process by arrangement between these bodies, which will report periodically to the appropriate authorities in OMVS and to the National Committees. Major modifications involving revision of quantitative objectives will be submitted to the Council of Ministers for decision.

This concerted planning process has in fact already started; when the National Master Plans were being prepared OMVS played an advisory role, and the State corporations in their turn were associated with the work of the socio-economic study.

The establishment of a system of continuous feedback/assessment of development performance to follow on from the economic study will be the institutional foundation on which the planning system can be built and developed.

5.5. CONCLUSION: ASSESSMENT OF DEGREE TO WHICH THE PRE-INVESTMENT PROGRAMME IS REALISTIC

We have set out above a pre-investment programme model which, to be applied, would involve re-appraisal of the national pre-investment projects already being undertaken or at various stages of preparation.

Our object was to provide a basis, in the first place, for discussing the utility of a systematic pre-investment programme to prepare the way for large-scale development, and secondly to consider whether the aim of reaching in four years a development capacity of 10,000 ha/year is a realistic one.

As between a strategy of gradually increasing development capacity, say at a rate of 20% to 30% a year, which would take some years, and a strategy of systematic preparation which would enable the necessary structural changes to be made in all the areas already cultivated, and development methods to be perfected by a sequence of pilot operations before major development is begun, it is the second of these which we maintain will best guarantee success and provide the key to mastery of the whole development process, and this for the following reasons.

First of all, it will be easier to organise the development corporations' structures and prepare a programme which will not begin until the institutions and methods to be used to carry it through are carefully prepared for the task and the means of executing it have all been mobilised, rather than widen the sphere of action simultaneously with this restructuring, and with working out new concepts of irrigation schemes, social organisation and farming methods; the more so as there must be a minimum of coherence between these several actions.

Then, as to the new institutions to be established - in particular, the training centres - we think it is easier to organise a centre designed to operate at a certain capacity, and operate it at that capacity until it is running smoothly than to set one up in a hurry and have to increase its capacity by 20% - 30% a year even before it is through its teething troubles. Furthermore, this second type of approach presents an additional risk, that of proliferation of institutions and of "balkanisation" of concepte, since each development project will tend to create its own training facilities as it is uncertain that the common training programme will be able to match the ever-increasing demand.

Finally, it seems to be a risky business to launch into development on a major scale without first establishing a planning system capable of monitoring performance and guiding the execution of the programme. And here we wish to recall that there is a time-lag before the effects of under-capacity at the overall management level make themselves felt.

As to the realism of the objective of reaching an overall development capacity of 10.000 ha/year on both sides of the river within four years - the timetable proposed for the pre-investment programme seems to be reasonably cautious, i.e. the length of time allowed for each operation is realistic; moreover it will be possible after the first two years to stretch the total programme to five years instead of four without seriously disturbing the consistency between the different programmes' components.

Insofar as concerns human resources, the listing of required qualified personnel and specialists which we have made, indicates that they can to a large extent be met from local resources, and the balance obtained without undue cost through external technical assistance, and that this number of additional staff can be absorbed over the four years of the programme, and can be managed, especially if caution is exercised in extending the acreage developed for cultivation during the preparatory period.

A further important question is whether the institutions and methods which have been worked out will be sufficiently perfected to enable large-scale development to begin.

Experience of irrigated farming has now been accumulated over 10 years, and covers an area of 17.000 ha (1) involving some 30.000 farmers. If we consider that a farm on average represents 9 persons (cf. ch.C.II, the total population cultivating irrigated land amounts to 270.000, or more than 70% of the total population engaged in flood-recession farming, estimated by Lericollais at 364.000 - delta included - or nearly 2/3 of farms) with very varied forms of organisation, cultivation and supervisory assistance, this experience may be thought to furnish a firm basis on which to test and refine working hypotheses.

(1) Excluding the sugar project (6.400 ha) which is informative only for the development of agro-industries.

The socio-economic study has made possible systematic measurement of yields (which in general are satisfactory and for the upper third exceptional) and identification of the principal factors affecting them. It has also enabled us to judge the efficacity of different institutions and their adaptation to the socio-human context of the Valley. The indications so obtained will be further tested during the next few years on the Dombo-Thiago and Boghé projects; and at the end of this long process the concepts of large-scale development should certainly be ripe for application.

A last important aspect to be considered is the constraints exercised by finance. It is not for us to assess the prospects of obtaining the finance necessary for a high rate of development. Be it noted however that so far finance has not been an obstacle to increasing the rate of development. On the other hand, if such increase involves an additional financial effort it may also, properly conducted, result in a reduction of construction costs. This introduces the question of the effect of different modes of funding on development rates. The prime condition for achieving a high and regular rate of development is to obtain the commitment of funds sufficiently ahead of the need to disburse them, in effect to build up in the next few years a pipeline of funding commitments alongside the constitution of a pipeline of construction studies.

A second important condition is to arrange the financing of the pre-investment programme separately from that for developing irrigated areas. As we have several times pointed out, the tendency for projects to be self-sufficient, each with its own training and research component, is incompatible with the requirements of take-off into major development, and would lead to a balkanisation of structures which would make the control of the development process impossible.

Thirdly, and once again to repeat what has already been said elsewhere, funding sources should either commit themselves to financing a large package, or accept arrangements for joint financing to enable fewer, larger projects to be undertaken.

These three conditions are indispensable pre-conditions to embarking on large-scale development.

E.VII. 6 THE PLANNING OF THE PHASE OF LARGE-SCALE DEVELOPMENT

The main planning problem in this ensuing phase will be to supervise the use of resources and the application of factors built up by the pre-investment programme in order to obtain high regular yields, and especially an intensification coefficient approaching 2 when the river-flow is regularised (which will be in 1985 for the area affected by the Diama Dam and 1986/87 for the rest of the Valley when the Manantali Dam comes into service) with the development rate of 10.000 ha.

This planning will rely essentially on the system of monitoring and evaluation of development performance, which should give timely warning of any need to modify the programmes and methods of preliminary training and supervisory/extension suport for initial cultivation, or to correct the overall management system, or the system of logistic support.

If the pre-investment programme has been correctly carried out in the preceding phase it should be possible to make such changes without having to slow down the development rate. Nevertheless, it will be well to consider how flexible the programme is, in case such a slow-down should become necessary.

Of the two components in the irrigation development programme, it is that of the small schemes which offers a good deal of flexibility. Thus the overall programme might be reduced by 2.000 to 3.000 ha without delay. The temporary increase in supervisory/extension support costs during the initial phase of cultivation, and subsequently in normal farming conditions, would be entirely acceptable.

This shows that a temporary slowdown of development rates is possible, and would not raise any major problems.

In our view, the attainment of a high intensification coefficient depends chiefly on the following factors:

- The training of pilot-peasants, and the influence they can bring to bear on reducing work-times. If working times do not allow an intensification rate close to 2, it may be necessary to consider two possible solutions - in the short term, a reduction of the acreage allotted to each farmer, in the medium term, mechanisation.

- The training of tractor drivers, CUMA mechanics, and technical assistance support for the management and operation of the CUMA during its initial period of operation. A revision of methods of training and extension should enable machine-utilisation to be progressively improved.

- The motivation of the farmers. The main lever in this respect would be to raise the price of irrigated products. But our observation leads us to believe that motivation in favour of irrigated farming will remain strong even if during the next few years both rains and flood-levels should be favourable.

- Forecast of areas developed for irrigation up to 1990

Areas developed at end-1979	20.000 ha
Development forecast for preparatory period (1980-84)	12.000 ha
Forecast for period 1985-87	30.000 ha
Forecast for period 1988	10.500 ha
Forecast for period 1989	11.000 ha
Forecast for period 1990	11.500 ha
Total area developed at end-1990	95.000 ha

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CHAPTER E.VIII

THE AGRICULTURAL DEVELOPMENT OF THE UPPER BASIN

INTRODUCTION

In earlier chapters we have examined the obstacles to the development of irrigated farming in order to identify the means of accelerating and improving its output.

That analysis holds good for irrigated farming throughout the Basin. We now propose to examine its part in overall agricultural development policy from the angle of the development objectives jointly adopted by the member-States of OMVS.

We showed in Chap. E.VI (geographical distribution of irrigation schemes) that given adequate rates of irrigation development and sufficiently high yields, the potential of irrigable land in the Middle Valley and the Delta can provide improved, stable incomes for the whole of the agricultural population of the Valley together with full employment in farming.

For the Middle Valley, then, development strategy essentially is to substitute, as quickly as possible, intensive irrigated farming for the traditional rainfed and flood-recession extensive farming hitherto practised.

In contrast, in the Upper Basin irrigable areas, as yet insufficiently identified and mapped, are unlikely to exceed 50.000 ha as a maximum (see Chap. A.I.6.); thus here development cannot of itself guarantee an income to the Upper Basin's agricultural population.

On the other hand, over most of the Upper Basin the rainfall is favourable and varies less from year to year than in the Middle Valley.

There are in fact substantial possibilities of improving rainfed cultivation.

Agricultural development in the Upper Basin should therefore rely on combining rainfed and irrigated cultivation, and this invites attention to the development problems of these two sectors.

2. THE DEVELOPMENT OF IRRIGATED FARMING

In this sector, whilst the restrictive factors identified elsewhere are also present here, the Upper Basin is subject to additional constraints.

In Chap. C.I. we saw that at present in the Upper Basin 170 ha have been prepared for irrigation, but despite continuing extension of the irrigated acreage, areas that are cultivated each year have not exceeded some 50 ha since 1975.

Insofar as cereals are concerned, the reason for this is the disparity between the external and internal price systems, and for vegetable crops the lack of trade outlets, the market in practice being restricted to the limited demand of local urban centres (i.e. Kayes and Diamou).

The problem for irrigated farming in the Upper Basin is that it must make substantial use of external inputs (equipment, fuel, fertiliser, pesticides) and that these have to be paid for by selling the product at internal Mali prices.

The Malian price system has brought about structural distortions in the country's economy and finances which will take a long time to correct. The prospects of restructuring the price system depend on the possibility of increasing agricultural productivity.

Is the development of irrigated farming in the Upper Basin caught and held back in a kind of vicious circle? In our belief, no, but the handicap of the price structure must be taken into account in devising a suitable irrigated production system for the Upper Basin.

This means that it should include an export crop component sufficient to pay for the important inputs necessary for intensive irrigated farming.

Agronomic research should therefore be directed towards delivering technological packages combining subsistence cultivation with export crops which are economically feasible in the specific conditions prevailing in the Upper Basin.

More precisely, given the pluviometric régime of the Upper Basin, a double (or triple) crop system must be worked out to include:

- A rainy-season crop for subsistence, in which irrigation would be employed only to eke out temporary shortages of rainfall (the economic realities requiring that the consumption of fuel and maintenance be paid for by increased output at internal prices). This crop will benefit from the residual effect of the artificial fertiliser applied in the dry season, and from the use of biological fertilisation.

- One (or two) irrigated dry-season crops produced for export and sufficiently profitable to pay for the amortisation of equipment and the imported inputs.

Agronomic research is already at work in these directions, and is concentrating on selection of suitable varieties and the appropriate techniques.

As to dry-season farming, the experimental programme includes the following crops with export possibilities; groundnuts (especially table nuts for direct consumption), soya, irrigated cotton, cassava with supplementary irrigation (the European market imports every year five million tonnes of dried cassava roots).

Annexe E.4. gives an idea of present areas of research. The programme could well be made more systematic by a continuous economic assessment of the results obtained, which could orient research towards the development of comprehensive economically viable crop systems.

But the development of exports crops will only be possible if they can be evacuated; this is a point to which we shall return.

And it is very desirable that irrigated farming methods in the Upper Basin should be adequately tested on the ground before full control of the river-flow is established in the years 1987-90 and large-scale development can be launched.

For this purpose existing irrigated areas should be used as a pre-extension ground to try out the findings of agronomic research and determine macro-farming systems that are both economically feasible and socially suitable.

3. THE DEVELOPMENT OF RAINFED AGRICULTURE IN THE UPPER BASIN

3.1. The possibilities

Although insufficiently explored and identified, these are, in the upper Basin, substantial and less subject to fluctuations than in the Middle Valley, since the rainfall is more regular.

From the angle of agriculture the topography, soils and especially rainfall divide the Upper Valley into three clearly-marked regions:

3.1.1. The southern region comprising Kéniéba district and the southern part of Bafoulabé district (excluding Kita district on the outer limit of the Basin and oriented rather towards the region of Bamako).

In this region rainfall increases from the North (700 m/m) to the South where it exceeds 1.000m/m on the Guinean border.

However, if the rainfall favours rainfed cultivation this is offset by the limited amount of fertile land, due to the existence of vast lateritic plateaux from which the topsoil has been leached out and impoverished by surface runoff and sheet erosion. The main crops are millet, fonio and groundnuts, outputs being on the increase thanks to the work of the O.A.C.V. (Operation for Groundnuts and Food Crops).

In the extreme south there are orange, banana, mango and other fruit plantations where the production potential is far from being fully exploited by reason of poor communications which hamper evacuation and marketing in other regions.

Finally, the valleys and lowlying areas where the most fertile land is to be found are under- or unexploited because the prevalence of oncocerchiasis prevents human settlement.

This applies particularly to the low lands of the Falémé in the West, to those of Bafing in the Centre, and to the lower glacis of the Mandingue Plateau in the East where rice is planted only occasionally, and by very extensive methods, by farmers who come down from the plateau to perform the minimum necessary operations without staying in the planted area.

3.1.2. The Central Region covers the whole district of Diéma, the northern part of Bafoulabé district, and the southern parts of Nioro and Yélimané districts. Rainfall in this region varies between 500 m/m in the North and more than 1.000 m/m in the South. At Kayes, where the mean annual rainfall is 789 m/m, the annual variation is from 143% to 63%.

In terms of agricultural potential there are three distinct areas to be considered;

- The River Senegal zone where the main possibilities are in the river plains, chiefly those of Mahina, Maleus-Konuta and Sama. This zone is under the responsibility of the OVSTM which has developed some irrigation schemes, the main crops grown being millet, sorgho and groundnuts. Thanks to the railway, this area is less land locked than any other in the Upper Basin.

- To the North-East of Kayes is the Térékollé-Magui system for which OVSTM is likewise responsible. Here the main possibilities are in the area of Lake Magui and the Doro Pool where both rainfed and flood-recession crops can be cultivated. The main products are rice (in the rainy season), maize, (rains and dry season), gourds, groundnuts and miébé.

- In the North-East of the central region, in Diéma district, lies most of the area of Kaarta, where there are many pools and seasonal streams in valleys running from North to South, wide, gently-sloping, and fertile (Sandaré - Makana - Diéma). The staple crop is millet but there are also maize, sorgho and a little rice. This zone is also handicapped for development by endemic diseases, chiefly oncocerchiasis (Marentoumania - Diataya), Guinea worm (Sandaré - Ségala - Koniakary). In part, the intensification of agriculture will depend on the control and eradication of these diseases.

The development of Kaarta has been entrusted to O.D.I.K. (Operation for the Integrated Development of Kaarta) which has been equipped to carry out multiple activities, and including in its programme 9 spheres of action; agriculture, stockraising, water and forest resource-management, training, functional literacy, farm roads and tracks, hydraulic engineering, health, cartography. ODIK has started off by collecting data and basic studies on each of these sectors in order to plan an integrated multisectoral programme. In tackling the obstacles which are holding up rural development in the Upper Basin, this comprehensive approach seems to us to be very much the right one.

3.1.3. The Northern Region covering the Northern parts of Nioro and Yélimané districts is mainly suited to stockraising and sylviculture, but on the confines of the Térékollé at Yélimané and in Western Kaarta at Nioro conditions are favourable to agriculture.

3.2. Limiting factors on the development of rainfed cultivation

Assessment of the potential for rainfed (and to a lesser extent food-recession) agriculture brings into relief the main limitative factors hindering development in the Upper Basin at the present time.

First of all, there is the enclavement which restricts all the areas more or less distant from the line of rail virtually to production for subsistence needs.

The products which could be exchanged for those of neighbouring regions, and the export crops which are the foundation for the development of a cash economy have not been developed on a significant scale for want of the means of evacuating them.

Secondly, the inadequacy of basic information, particularly about land resources, prevents systematic integrated programmes from being worked out, or applied according to a coherent scale of priorities.

ODIK's multisectoral approach beginning with the collection and study of basic data in order to set up an integrated development programme should be applied to all zones with a favourable potential, and in particular to lowlying areas and those in the southern region suited to plantation agriculture; likewise to the Térékollé and Lake Magui in the central zone (1).

Detailed knowledge of the potential and development prospects of these regions will enable a timetable of priorities to be set up and a transport development plan to be drawn up which will be a necessary prelude to development in each of the zones.

Finally, in the same way as for irrigated farming, agronomic research must determine for each zone what is the optimum product-mix between export and subsistence cultivation, enabling the cost of imported inputs to be covered on an economic basis.

This will involve a closer institutional relationship between agronomic research and development operations.

Lastly, the agricultural development of the Upper Basin will turn on the success achieved by a programme set up to control endemic diseases, particularly oncocerchiasis, a programme which will take account of changes in river-flow brought about by the Manantali Dam.

4. THE IMPACT OF REGULARISED RIVER-FLOW ON AGRICULTURAL DEVELOPMENT IN THE UPPER BASIN AND THE NEED TO PREPARE AN INTEGRATED PLAN FOR ITS DEVELOPMENT

To complete the analysis of the factors limiting agricultural development in the Upper Basin the impact on it of the Manantali Dam when it comes into service must also be examined. Over and above its direct effects on the exploitation of irrigable land in the Valley, the regularisation of river-flow will have important secondary and induced effects for the development of the Upper Basin in general and that of the agricultural sector in particular.

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(1) Those of the Senegal Valley plains which are irrigable have already been dealt with in para. 2 above.

By opening up navigation from Kayes to the sea the regularisation will also widen the prospects of agricultural development by making export crops economically feasible and by promoting exchange of complementary products with the Middle Valley. The latter is in fact very suited to irrigated cultivation, especially of rice, and should gradually make up the shortfall in rice production in both Senegal and Mauritania; on the other hand it is already in deficit and will progressively become more so in millet and sorgho; in large part it will fall on the Upper Basin to meet the growing demand for these food staples in the Middle Valley.

The waterway from Kayes to the sea is thus a necessary complement to the roads planned to open up the Upper Valley. Conversely, the establishment of a feeder road system in the Upper Basin centring on Kayes is needed for the development of river traffic. These two complementary investments should therefore be made simultaneously.

Finally, agricultural development in the Upper Basin cannot be planned independently of development in the secondary and tertiary sectors, and this in turn will be affected by the opening of the waterway from Kayes to the sea and by the power which will become available when the Manantali Dam is completed. The interdependence of different sectors in the development of the Upper Basin will be discussed in volume F of this report (interpretation of results of socio-economic study for other sectors; and intersectoral problems).

We confine ourselves here to noting that the Manantali Dam will open up important possibilities for the development of the Upper Basin, and more especially for its agricultural sector.

To realise these possibilities and exploit the resources which will be available from 1985 and integrated development plan for the Upper Basin is an urgent necessity. Crucial to it will be a plan for developing a feeder-road network to serve the navigable waterway.

This transport plan will accentuate in turn the need to proceed more quickly with the task of making an inventory of the Upper Basin's agricultural possibilities and especially its resources in land.

The preparation of a multisectoral integrated plan is the main plank in a pre-investment programme for the Upper Basin.

In the field of agricultural development pre-investment activities should include:

- Intensified research to establish a system combining rainfed with irrigated cropping on the one hand, and production for local needs and for export on the other;

- Intensified reconnaissance of land resources;

- Classification of the areas affected by endemic diseases, especially oncocerchiasis, and the preparation and execution of a programme to bring them under control.

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CHAPTER E. IX

THE EVOLUTION OF THE ENVIRONMENT AND THE DEVELOPMENT OF IRRIGATED FARMING

INTRODUCTION

The effects on the environment of regularising the river flow and developing irrigated farming have been the subject of a separate study. We shall confine ourselves here to examining a few important aspects of the influences recipracally exercised each on the other by the evolution of the socio-economic environment of the Basin and the development of irrigated farming; and specifically to three aspects which seem to be particularly important:

- The combined influence of drought and emigration on the constraints affecting the development of irrigated farming,
- the balance between production and consumption of energy in the Basin, taking into account the effects of development,
- the impact of the development of agriculture on the stockfarming sector and its effects on the environment.

I. DROUGHT, MIGRATIONS AND MOBILISATION OF THE LABOUR FORCE TO PROMOTE AGRICULTURAL DEVELOPMENT

I.1 Drought and migration

What have been the principal phenomena marking the socio-economic evolution of the Valley since independence? There seem to be three which in combination have deeply affected the future of the Valley and its population; they are: emigration and drought which have set up a veritable vicious circle of economic regression, and the introduction of irrigated cultivation which in the context of the programme to harness the river seems to be full of promise for the economic rehabilitation of the sub-region.

Emigration in the Valley takes two forms, both of fairly long standing; semi-permanent or permanent emigration towards urban centres outside the Valley and especially towards the national capitals, and temporary emigration either to those same centres, or to other centres whether in Africa or possibly Europe (cf. the Soninké "navigator" tradition). The analysis in Ch. B.3 shows how these migratory currents have amplified in number and duration and spread to almost the whole population of the Valley over the past twenty years. Taking into account the rate of natural population increase which the demographers put at between 2.4% and 2.6% for the three countries of the Basin, the overall balance between natural increase and emigration is still positive, and represents a true population increase in the order of 1% to 2% according to area. But it is important to note that this global increase is not "balanced', in that the migrant flow is made up chiefly of young and adult men, so that the net result of these two tendencies - population increase/ emigration - shows up in an increase in the proportion of non-active to active members of the Valley's population, and is reflected in a relative drop in production, per capita of all residents.

The overall economic effect of migration is ambiguous.

On the one hand, cash remittances from migrants represent - as we have seen - considerable sums, amounting according to area to 30% to 75% of cash incomes, and they are essential in years of drought (6 out of the last 10) to ensure the subsistence and even survival of the population remaining in the Valley; and in times of normal crop yields they represent a very useful investment potential for development purposes.

On the other hand, village economies have to provide for:

1) the maintenance and education of the youths before they leave at about the age of 20

2) the maintenance of the emigrants' families (wives, children, elderly dependents, etc.) throughout the period of their absence

3) the maintenance of workers and their families when they decide, often in sickness or old age, to come back to live in the village.

Of course, this kind of analysis is necessarily theoritical, since the choice for the young men is not simply in terms of going or staying; the general consensus as well as economic conditions leave them less and less option, from one year to the next, but to go.

At this level of analysis, the second phenomenon which we have said weights heavily on the future of the Valley makes itself felt; it is the drought which has afflicted the Sahel for the past 10 years and - alas! - judging by 1979 data shows no signs of coming to an end. In fact, the succession of years of poor rainfall and low flood-level since 1968 seem to have completely dismantled the economy of the Lower and Middle Valley - the Upper Basin having been much less affected over the period. The earlier years 1968-73 saw a general drop in production levels in the three main sectors: agriculture, stockfarming, and fishing; cattle herds were literally decimated in the year 1972/73; the shortfall in cereal production is of the order of 80-90%; the effect on fishing has been disastrous if more difficult to assess (virtual disappearance of some species, reduced catches both in numbers and weight of fish).

After the 1975 respite, drought returned in 1976-77, and 1979 seems to be marked by a flood-level as low as that of 1972. The cumulative effects are incalculable, notably on the regeneration of pasture land and by destruction of forest reserves; the gum-tree forests which for centuries were the fame and fortune of the Valley seem to have been irretrievably stricken. The Valley, for long the "millet-granary" of the sub-region, has seen its cereal deficit settle more or less permanently at between 50-80% of its own needs, whereas twenty years ago, taking one year with another, it was still capable of exporting 5-15,000 tonnes of millet/sorghum a year.

The effects of the prolonged drought, which has completely drained the village economy, can be seen mainly in three fields:

- the acceleration and extension of migratory currents. As was demonstrated in the analysis of migration in Ch. B III the general drop in production levels inevitably encouraged a massive exodus to the towns, a movement which on a smaller scale was already of long date in some parts of the Valley. Often enough, this was the price to be paid for the very survival of family and village communities - emigration of the young men, followed by their money orders which had to meet daily subsistence needs. Gradually, as the years went by, a situation of "complementarity" grew up between the villages of the Valley and the towns: Dakar, Nouakchott, Nouadhibou, Abidjan, Libreville, Paris, Lille, Marseille where groups of workers from the Valley have been settled for many years who literally, by their savings and remittances, keep their home populations in the Valley alive.

- the destruction of traditional, and the growth of marginal activities in the urban centres of the Basin. The trading economy traditionally based on the collecting of gum and the marketing of cereals has been totally disrupted. The principal consequence has been the decline of the commercial and economic role of the trading-posts. The general drop in the level of production as a result of emigration, and the build-up of a road network entailing the virtual disappearance of river traffic had already had an unfavourable effect on these posts. The growth in population which some urban centres have experienced, especially on the Mauritanian side, is proof that they have been able to offer a place of refuge to some rural elements, notably nomads retreating from the drought. This increase in population marks a positive decline in certain branches of activity - e.g. commercial and artisan - which the growth of administrative activity has failed to compensate. Thus most of the incoming migrants have swelled the ranks of the underemployed in marginal sectors.

- the general decline in production levels, some of the effects of which, such as the impoverishment of grazing land by the disappearance of certain types of vegetation and the partial destruction of forest and fishing resources, seem to be irreversible. On the socio-economic plane these phenomena show up in a kind of pauperisation, or even marginalisation, of some categories of the population. Although after 1972-73 some part of the stock of cattle has been reconstituted (1) not all stock-farmers have been able to rebuild their herds; apparently it is just those who had the biggest herds who have been able to rebuild, whilst those with only a few head of cattle, all lost in the drought, have been unable to do so; some groups of Peul would seem to be in this position.

Similarly, amongst those living chiefly by agriculture the smallness of the areas cultivable in oualo has produced conditions such that the only chance of survival for many of them has been to emigrate or to find casual employment as labourers, water-carriers, or domestic servants.

Thus the Valley is witnessing the emergence of a true rural proletariat, in which the great majority of Haratine Moors can be found alongside Peuls and Toucouleurs, in particular the descendants of former captives, and landless peasants.

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(1) S. Santoir, op.cit.

Yet it must be remembered that along with these deplorable effects the crisis brought on by the drought has also stimulated the development of irrigated farming (as was analysed in Chap. C.I.).

I.2. MIGRATIONS, AND MOBILISATION OF THE LABOUR FORCE TO PROMOTE AGRICULTURAL DEVELOPMENT

These migrations have often been regarded as a serious handicap for all projects to develop agriculture in the Valley. This opinion however needs to be significantly qualified. In the first place, a distinction has to be made between permanent or semi-permanent, and temporary, migrations. The former generally involve entire family groups (men, wives and children) and are part of the process of rural exodus and urbanisation which goes along with development in almost every country in the world. But the latter, the temporary migrations, are chiefly of men between 15-55 who go away for several years leaving their families in the villages, and these can indeed be a source of labour bottlenecks for hydro-agricultural development projects which are being or will be introduced in the Valley in conjunction with the regularisation of the river-flow.

About these temporary migrants it is necessary to say at once that if they returned in massive numbers to their villeges this would, in present conditions, produce almost catastrophic consequences for the economy of the Basin. As things are, by their cash remittances to their families in the villages they are for most of the sub-regions in the Valley the principal source of money income; this is probably so throughout the zone upstream from the Middle Valley (Kaédi, Matam, Bakel, Sélibaly, Ololdou) which receive very large amounts from workers who have emigrated to France. As we have already emphasised, it is this income which in the years of lean crops due to poor rainfall and low flood-level, enables the inhabitants of the Valley to buy the means of survival. It is also true that a large part of the money, over and above what is spent on subsistence needs, goes to buying "prestige" goods, whether on an individual (jewels, houses, etc.) or village basis (mosque, radio...). There is nevertheless some investment in the productive sector, e.g. purchase of cattle is fairly widespread, or large motorised fishing canoes.

It is emigrants' remittances which pay also the cash costs of any hydro-agricultural inputs, e.g. fertiliser, motor fuel, the wages of paid labour (at peak periods in the agricultural season these may often be Moors or Malians). Less often, but cases have been known, the money is used for a durable investment; purchase of a tractor or motorcultivator, contribution to the acquisition or amortisation of a motor pump unit. (1)

However, much of the emigrants' savings is at present channelled via the Valley towards investment in the urban centres. It could well be redirected towards developing irrigated farming when this has reached a scale big enough to open up investment opportunities in production and ancillary services.

Looking at it strictly from the point of view of the availability of labour, is emigration today a cause of bottlenecks for development projects? In fact, investigations carried out over recent crop seasons indicate that there seems to be a limit to irrigated acreage beyond which the farmer's available labour is insufficient, at least at certain peak periods in manual farming.

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(1) A Kanel (Department of Matam) association, "The Kanel Confraternity" "proposes to make a financial contribution to installing a solar heat pump"(reported in Le Soleil, 22.11.1979).

In present conditions, i.e. taking into account that the techniques of irrigated farming have as yet been only recently and imperfectly acquired, and that traditional farming continues to be practised, it has been estimated that this limit is somewhere between 60 and 75 ares per farm, and that family labour shortages are felt only during the rainy season, in July, October and November, and then only in the category of able-bodied men (adolescents and adults).

But it must be emphasised that at the present time when only about one-third of the agricultural population benefits from access to irrigated farming, and individual irrigated plots are mostly fairly small (0.40 ha per farmer) bottlenecks have not yet made their appearance, the more so since (as was pointed out in Chap. C. IV) the social tradition of mutual help enables the labour of those who do not yet possess their own irrigated plots to be at the disposal of those who do. This results in an overall reduction in under-employment in agriculture and redistribution of the product of irrigated farming which is very welcome in present drought conditions.

We are inclined to believe also that the unusually high time allocations which were observed for a number of farming operations is largely due to the "mutual help" tradition and the obligation which this puts on the "well-off" to share their incomes with the poorest, by providing them with work opportunities against a share of the crop.

Thus the effects of emigration on the manpower needs of irrigated farming will be felt only gradually. This raises the question - will the accelerated development of irrigated farming bring about a gradual slowdown of the rate of emigration?

Another aspect to be kept in view is, if a cycle of abundant rains and high flood-levels should return, would available manpower be allocated in priority to irrigated farming or to traditional farming?

E.IX.2. ENERGY SOURCES: WOOD AND CHARCOAL ANALYSIS AND INTERPRETATION OF FINDINGS - RECOMMENDATIONS (1)

Interpretation of the findings and recommendations concerned with the exploitation and management of forest resources involved analysis and extrapolation of the quantitative data derived from the study of the production and consumption of wood fuels (see Chap. B.11.1).

2.1. OVERALL BALANCE SHEET AND ANALYSIS OF FINDINGS

2.1.1. Overall estimate of amount of wood fuel extracted annually from forest of the Middle Valey

(1) This chapter has been written by Mr. Adadou Camara in the course of preparing a thesis.

Procedure adopted

Wood fuels being used in the two forms of fire wood and charcoal, it has been necessary to convert charcoal production and consumption into the equivalent of wood for combustion.

The accepted conversion ratios are:

1 stere of wood = 0.4 tonnes of wood

5 tonnes of wood = 1.0 tonne of coal

Density of wood (gonakié is the prevailing species in the forests of the Middle Valley) = 0.810 g/cm^3 (grammes/cubic centimetres).

Volume of wood fuel consumed for domestic purposes

The above volume must be understood to mean firewood used in the household together with the coal-equivalent of firewood. Added together, they give an average per capita annual consumption of 0.682 m^3 or 1.38 steres (1).

This average consumption per person (C) related to the total population of the Middle Valley in 1977 gives the volume (V) of firewood consumed annually in the Middle Valley.

C = 0.682 m^3

P (1977) = 539,022 inhabitants

VI (C x P) = 367,613 m^3 = 743,850 steres = 297,540 tonnes.

Volume of wood fuel "exported"

This means the equivalent in wood of the charcoal supplied to the large towns. Its volume (V2) corresponds to the average annual volume of the left bank (VC) and of the right bank (VD) added together.

V2 = VG + VD = 172.500 t + 65.195 t = 237.695 tonnes.

Annual overall volume of wood fuel

This is the sum (V) of the volume of woodfuel consumed domestically (V1) and of the volume "exported" (V2).

V = V1 + V2 = 297.540 t + 237.695 t = 535.235 t = 1.338.100 steres.

This figure expressed the annual consumption needs of the Middle Valley for combustible wood. But to provide data for planning, it is necessary to compare these figures with available resources. It is possible to have an idea of the latter, at least theoretically, by studying what has happened to the forests of the Middle Valley since 1972 (date of latest estimate by Perroudin of standing timber).

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(1) Cf. chapter B.11.1 - page 10.

2.1.2. Forest reserves - their evolution in the Middle Valley since 1972

A few figures for reference:

- Density of Middle Valley forests (gonakié species): $120m^3$/ha = 240 steres/ha
- Rate of annual growth: 3.5 steres ha/year
- Losses due to drought (1973-77): 37%

In 1972, the forest area of the Middle Valley was estimated at 60.096 ha, representing a volume of 14.423.040 steres; hence an average growth of 210.336 steres and an overall growth between 1972 and 1979 of 1.472.352 steres.

On this basis, the potential theoretical volume of Middle Valley forest in 1979 can be calculated at 15.895.392 steres. Between 1973 and 1977 losses due to drought are assessed at some 5.881.295 steres, representing a true theoretical volume in 1979 of 10.014.907 steres, say 41.725 ha.

Between 1972 and 1979, 18.371 ha. have been lost, or 2.624 ha/year (annual loss of 4%).

It is important to note, and in our recommendations we shall return to the point, that this "trade-off" is negative to the extent that the ratio of gain-from-annual-growth to losses-due-to-drought is 1:4 in favour of the losses.

2.1.3. Relation between woodfuel production and forest reserves: the problem of renewable resources

This requires a balance-sheet to be drawn up of the exploitation of forest reserves for the production of wood fuel (firewood and charcoal), and in particular of future exploitation having regard to the present volume of resources.

For the purpose of analysing the evolution of these reserves, we propose to begin by estimating how many years it will take to exhaust completely the existing reserve as of this date, at the present rate of exploitation. This will enable us to judge whether the rate of forest growth will or will not be able to compensate consumption, and to decide the limit to be applied to consumption if reserves are to be maintained. It must be admitted that this is an optimistic approach, since it assumes on the one hand no further loss by drought, and on the other leaves out of account the effects of regularised river-flow by way of a reduction in annual flood-level reducing the area flooded seasonally and the consequent destruction of part of the gonakié forests. This is a point to which we shall return later. (1)

On the hypothesis so defined we can use the following figures:

(1) See Perraudin report.

- Potential volume of wood in the forests of the Middle Valley is estimated at 10.015.000 steres in 1979.
- Present annual production (of wood fuel) is estimated at 1.338.000 steres.
- The existing stock will thus be used up in 8 years.

Clearly, the present rate of felling has gone far beyond that at which a balance can be maintained, and the growth of young trees cannot possibly replace in 8 years the volume of timber now standing.

There is thus an ever-more-imperative need to work out short-term measures to retard as long as possible the point of no return in the destruction of the natural equilibrium, and to undertake in the medium and long-term large-scale actions, fitting into the overall policy of agricultural development in the Valley, to stave off this calamity deriving simultaneously from manmade and from natural causes.

2.2. STUDY OF MEASURES TO BE TAKEN TO RESTORE THE BALANCE

2.2.1. Short-term action

Some practical and very feasible measures can be taken relatively quickly.

2.2.1.1. Identification and rational exploitation of dead timber in drought-stricken areas

This will be a matter of mapping the wooded areas most badly affected by the drought - they cover substantial areas - and organising their exploitation according to very strict rules. This type of forest is more extensive upstream from the Middle Valley (Matam-Bakel sector) than below, where, however, all the charcoal producers working in the Valley are concentrated. It is quite possible to make them aware of the position, and motivate them to act as policy requires, for example by exonerating all charcoal producers willing to work in these dead timber areas from the tax levied on every quintal of charcoal produced.

This would have the double advantage of avoiding cuts of green timber in forests which have been exploited to the critical limit, and of systematically clearing dried-up forests withering into old age, and preparing the way for their eventual regeneration. Both these advantages serve the same end; to restore the balance between forest growth and the losses occasioned by the drought, or even to tip it in favour of the former. According to the Perraudin report, flood modulation will cause a loss of 20% in forest reserves up to the period 1990-95. And in view of the effect of drought since 1973, it is time to bring this estimate up to date.

2.2.1.2. Co-ordination of action to prepare land for irrigation with the exploitation of forest reserves

In essence, this means recovering the timber from cleared land, and using it for fuel, and the developers must increasingly bring home to the peasants the need for them to combine their resources. In particular, villages should be allowed to supply themselves with firewood from the stocks of wood made available by clearance for irrigation schemes.

In practice, this will be a matter of involving the charcoal producers in site preparation, as was the case at Mbantou (NDioum district), or offering a credit to the peasants when the land is cleared, to be repaid by the sale of wood to the co-operative or to the charcoal burners. This would give them an incentive not simply to rid the cleared land of timber by burning it off.

2.2.1.3. Harmonisation by member-states of OMVS of their rules for exploiting forest reserves

Such harmonisation is all the more necessary since any initiative adopted for rational exploitation must be concerted between all the interested parties for at least two reasons:

1. The Valley, being an indivisible whole, calls for harmonious development as a whole, despite any cleavage of interest there may be as to respective shares.

2. Such an initiative will only be viable if it does not leave loopholes through which the charcoal trade can slip. In this regard, the general report mentions the (reciprocal) infiltration of charcoal producers from each side of the river to the other.

2.2.2. Medium and long-term action

2.2.2.1. A halt to "exports" of charcoal from the Valley to the major towns

Every year, some 47.500 tonnes of charcoal are drained away from the forests of the Middle Valley to the urban centres (Saint Louis, Louga, Thiès, Dakar for Senegal; Rosso, Nouakchott, Nouadhibou etc. for Mauritania). However, the saharo-sahelian borders of our countries are only wooded in the alluvial river valleys. As these forests are increasingly threatened by the effects of the drought, it is now essential that dead timber be retained as a stock of firewood for the exclusive use of the populations of the Valley. And there are alternatives to the "export" of charcoal from the Valley, which differ from one side of the river to the other.

a) For the left bank

For Senegal, the problem seems to be fairly simple. The country possesses other forested areas besides those in the Valley (Senegal-Oriental, Casamance, etc.). It is thus quite possible to take steps to spare the Northern forests (which have been more seriously affected by the lack of rain) by supplying the main towns from the more heavily-wooded areas of the Casamance, Senegal-Oriental, etc. by intensifying their exploitation if only temporarily to allow time for a coherent environmental policy to be worked out for the Senegal Basin.

b) For the right bank

Here the problem is more difficult, as the Valley is Mauritania's only wooded region, and - for this reason - is more intensively exploited than the left bank, especially in the area below Boghé. So for Mauritania the problem of a breakdown in environmental equilibrium is more acute. This is certainly the reason for the Mauritanian authorities' evident concern to find an alternative source quickly. One such, already under consideration, consists in stopping the "export" of charcoal from the Valley, and importing wood from more humid countries (especially those along the Gulf of Guinea) to supply the chief towns of Mauritania. Forest clearance in those countries (it appears) makes available annually vast quantities of dead wood which are a nuisance to the populations concerned, who practise shifting cultivation on a slash-and-burn basis. The only financial problem would to transport the wood, and Mauritania is on the point of launching a feasibility study of this alternative.

But these alternatives raise the question, on both sides of the river, of resettling the charcoal producers. This is possible, inasmuch as they also engage in agriculture as a subsidiary activity, especially since the introduction of irrigated farming. Such resettlement would be helpful also in view of the need to train "pilot-peasants" in re-afforestation and protection of the natural environment.

2.2.2.2. Improvement of cooking-stoves and methods of carbonisation

It is estimated that inefficient ovens and methods of burning fuel cause energy losses of 70% in the use of firewood and the making of charcoal. On the basis of present-day production of wood fuel, this amounts to wasting some 950.000 steres a year. A recent CILSS study proposes the introduction of more efficient stoves (cooking more quickly and thereby saving fuel) on the lines of stoves used in some Asian countries (Malaysia). This implies a campaign to educate the people in the nature and importance of the problem. As is well known, every innovation encounters resistance from rooted habits; and this is all the more true of people as conservative as those of the Valley. So in this respect serious problems may arise, in view of the pecuniary interests which may be at stake. But the fact that some African countries (e.g. Ghana) have managed to do it is an argument in favour of a propaganda campaign to promote innovation of this kind.

And there is a good case for including these changes in the programme for developing irrigated farming. In the first place, the transition from traditional to irrigated agriculture, as all our observations have tended to show, implies a social restructuring of the village community and far-reaching changes in the activities of the people, which will favour the introduction of new ways in domestic life. And secondly, irrigated agriculture leads to improved incomes, some part of which will be in cash, thus making possible the acquisition of kitchen equipment.

2.2.2.3. The use of substitute fuels

The gas oven (in Senegal) and kerosene burner (in Mauritania) have had a mixed reception in the major towns of these countries. Both have come up against the culinary habits of the populations they were introduced to serve. The soaring price of raw materials which is rocking the world (especially the under-developed world) is a weighty objective reason added to the subjective psycho-social factor arguing against recourse to petrol or gas as energy sources providing an alternative to deforestation. The authorities recoil more and more from the prospect of subsidising the price of these alternatives (petrol/gas); and the objective factors alone would suffice to exclude their use in the Valley. But there is a further factor; the income from irrigated farming (especially on the smaller schemes) is so small that the peasants simply could not afford the luxury of substituting petrol or gas for wood. This change, however desirable, must be a gradual long-term development accompanying the improvement of cash incomes in the Basin.

2.2.2.4. Re-afforestation, protection of nature, and training

The short and medium-term actions we have proposed above are intended to do no more than conserve existing forest reserves. But this capital has already been partly eaten up by the drought, which may well continue. And the regularisation of the river-flow will result in the long run in destroying much of the gonakié forest when flood modulation puts an end to its annual submersion. Finally, the extension of irrigated farming itself will lead to the clearing of some wooded areas.

Given the length of time needed for forest growth, it is urgently necessary to draw up and carry out a programme of re-afforestation on a massive scale. This will not be possible without converting the people to the need to conserve the ecosystem, and to their active participation in the work of re-planting and maintenance.

The introduction of irrigated farming, in which the population has shown growing interest, the change of attitudes which it involves and the immediate benefits it confers, together make up a unique opportunity to create an awareness in the populations concerned of their own long-term interests, especially in the matter of building up forest resources.

This association of afforestation with the development of irrigated farming has the further advantages that it will enable the whole agricultural population of the Valley to be reached, in time, and that the extra cost of including forestry in the overall costs of irrigated agricultural development would be relatively small.

In practice, it will be through the training of the pilot-peasants that the population can be made aware of the need, and initiated in the techniques of tree-planting. Advice and support in organising re-afforestation will be part of the general extension and support services provided during the first three years of cultivation on each perimeter. Similarly, the planting of windbreaks and re-afforestation around the boundaries of irrigation schemes will be included in the development studies.

Only forestry research and tree-nurseries will be separately financed. To give some idea of the possible range of such a programme, it may suffice to say that if every village managed within a few years to plant an area equivalent to that of its own irrigation scheme, by 1995 some 100.00 ha of new, growing forest would be planted, i.e. double the area existing in 1979.

ASSESSMENT OF TOTAL AMOUNT OF WOOD FUEL (FIREWOOD AND CHARCOAL) EXTRACTED ANNUALLY FROM THE FORESTS OF THE MIDDLE VALLEY

Average annual consumption of firewood per person
0,082 m^3 = 1,38 steres

Total population of Middle Valley (1977)
539,022 inhabitants

Volume of firewood consumed annually
367,613 m^3 = 743,850 steres = 297,540 tonnes

Average annual production of charcoal - Middle Valley SENEGAL
34,500 t equivalent to 172,500 t of wood

Average annual production of charcoal Middle Valley MAURITANIA
13,039 t equivalent to 65,195 t of wood

Average annual total production of charcoal in Middle Valley
47,500 tonnes equivalent to 237,500 t of wood

Total volume of wood fuel (firewood plus charcoal) extracted annually from Middle Valley
535,235 tonnes = 1,338,000 steres

Notes: 1 stere of wood = 0,4 tonne
5 t of wood = 1 tonne of coal
density of wood (gonakié species) = 0,810 g/cm^3

E.IX. 14

RATIO OF WOOD FUEL PRODUCTION/VOLUME OF TIMBER IN MIDDLE VALLEY FORESTS

1. In present Production Conditions

Volume of Middle Valley Forests (1979)
10,014,000 Steres

Annual Production of Wood Fuel
1,338,000 Steres

Potential Reserve (1)
8 Years

2. With Improved Kitchen Stoves and Methods of Carbonisation

Volume of Fuel Losses (2)
936,500 steres

Annual Volume of Woodfuel
Usefully Consumed
400,500 Steres

Fuel Reserve with Improved
Kitchen Stoves and Carbonisation Techniques
25 Years

(1) Most optimistic hypothesis, excluding annual population growth and possible losses occasioned by drought in future years.

(2) It is calculated that 70% of fuel energy is wasted by inefficient cooking stoves and poor techniques of carbonisation.

EVOLUTION OF MIDDLE VALLEY FORESTS SINCE 1972

Area in 1972
60,100 ha.

Volume in 1972
14,423,000 Steres

Average Annual Growth
210,500 Steres

Total Growth between 1972 and 1979
1,473,500 Steres

Potential Volume in 1979
15,896,600 Steres

Losses due to Draught 1973-1979
5,881,500 Steres

Presumed Actual Volume in 1979
10,015,000 Steres = 41,700 ha.

FOREST AREA LOST BETWEEN 1972 AND 1979
18,371 ha. or 2,624 ha/year

30% or 4 % a year

Notes:

Gonakié forest density: 120 m^3/ha = 240 steres/ha
Annual growth rate: 3,5 steres/ha/year
Losses due to drought: 37% between 1973 and 1977.

3. THE INFLUENCE OF REGULARISATION OF RIVER-FLOW, AND THE DEVELOPMENT OF IRRIGATED FARMING, ON STOCKFARMING

INTRODUCTION

Stockfarming calls for a separate study requiring resources not less than, and perhaps more than, the socio-economic study itself. Its geographical coverage goes beyond the River Basin to take in all the grazing grounds used by pastoral farmers who may benefit from the fodder made available by regularisation of the river flow and irrigated farming. What is more, the pastoral way of life and its social structures and modes of production are even more varied and complex than those of the "agriculturalists" properly so-called.

The pastoral study which should now be undertaken to complement the socio-economic study is a much more difficult one to formulate, both in its terms of reference and in the methodology to be adopted. We shall do no more here than offer a few fragmentary comments on the possible effect of regularised river-flow and the development of irrigated farming on stockfarming, in order to help to frame the terms of reference and work out an appropriate research methodology.

3.1. Characteristics of types of fodder available as a result of regularised river flow and irrigated farming

These developments will exercise an influence on stock farming as much by the by-products of irrigated cultivation as by the possibilities they will open up of growing fodder crops. The main characteristic shared by these benefits is their dependability in terms of regularity of production, both seasonal and from one year to another.

They can be classified as follows:

a) Fodder from pasture land subjected to controlled flooding, which will be possible when river-flow is regularised (Delta and various low-lying areas difficult to drain for water management purposes). Seasonal availability: end of dry season. Prospects for development: from 1985 for the Delta, following the construction of the Diama dam; from 1986/87 for the rest of the Valley.

b) By-products of irrigated cereal production (straw, stalks, bran). Seasonal availability: end of rainy season (from December); end of dry season (from March); end of hot dry season (from May). Growth prospects for amounts available: by-products from 35.000 ha at end-1985 growing by 10.000 ha/year from that date, and increasing by 5% a year from 1988.

c) By-products of sugar cane: at present the C.S.S. (Senegal Sugar Company) cultivates 7.000 ha, by-products from which are not used as feedingstuffs. This area is scheduled to be increased to 10.000 ha. Koundi III project provides for 4.500 ha to be in production from 1986/87, with by-products to be made available to stockfarmers.

d) Irrigated fodder crops.

A production potential can be developed from 1985 when river flow is regularised, but whether it will be economically feasible is still uncertain.

Two production systems can be considered, differing in their economic feasibility.

In the first, irrigated fodder crops would be grown as a supplementary resource by the stock farmers themselves, who would thus become mixed farmers. The feasibility of this system will depend on the sociological factors conditioning the pastoralists' way of life and the incentive to diversify it in part by taking up irrigated farming.

The second would be a system of irrigated fodder crop production by the cultivators for their own needs or for sale or exchange to stock farmers for raising or fattening cattle. The economic feasibility of this system is uncertain as yet, and will depend partly on progress in agronomic and zootechnical research and partly on the development of animal traction.

3.2. Long-term socio-economic implications of fodder availabilities resulting from regularised river flow and irrigated farming

To begin with, it must be pointed out that the prospects of increasing fodder supply are long-term and will only have a real impact on the livestock sector when the river flow has been controlled.

Until then supplies will remain limited, and mostly available at the end of the rainy season and the beginning of the dry season, when natural fodder is still abundant, but there are already some pointers to their usefulness in the dry season (sale of baled straw from irrigation schemes).

With controlled river-flow supplies will increase progressively. However, controlled flooding of pasture lands can be developed within a few years after the completion of the Delta Dam (1985-1990).

The long-term socio-economic implications of this fodder supply lie between two extremes:

First, the gradual development of a new agro-pastoral system as an annex of irrigated farming; a complete stockraising cycle totally integrated with agriculture. The cattle would belong to the cultivators who would either look after them directly or hand them over to graziers on the métayer (sharing) system. This would meet the needs for draught animals, for milk for human consumption and for meat production (fattening of store cattle for the market).

The long-term socio-economic implications of this system are: competition between the semi-intensive system based on irrigated farming with grazing on diéri pasture land near the dry-season river-bed on the one hand, and the sahelian extensive grazing system now cut off from its former natural reserves along the river, on the other.

The second system would consist in gradually restructuring agro-pastoral methods as the increasing availability of irrigated fodder supplies enabled the deficiencies and hazards of present extensive grazing practices to be overcome. Extensive grazing would be combined with accessory use of the fodder by-products of the regularised riverflow and irrigated farming. Sahelian cattle farming, improved but still basically extensive, would be partly for breeding and partly for milk, but with the added bonus of a final stage of fattening and a market in draught animals for irrigated farming.

In this perspective, fodder produced by irrigated farming will assume the following functions in support of extensive stock farming:

- To bridge seasonal gaps in pasturage (by controlled flooding of suitable pastures and by-products of irrigated farming);
- To enable the herd to be kept alive in years of drought (by controlled flooding + by-products + emergency crops planted in the cold dry season);
- Fattening for meat (by-products of agro-industry + irrigated fodder crops produced if possible by the stock farmers themselves).

The likelihood of one or other of these alternatives occurring are assessed as follows:

The first is the more likely, in the absence of a deliberate policy of remoulding agro-pastoral practices.

The long-term consequences of adopting this alternative are of two kinds. First, from the socio-economic point of view, regularising the river flow will do nothing to safeguard the living conditions of the pastoral populations of the Valley. Furthermore, it will progressively accentuate the disparities of income between agriculturists who will become agro-pastoralists and the pastoral populations who will be more and more confined to getting their living solely from the natural resources of the Sahel itself.

From the point of view of environment, deterioration in the plant cover of the Sahelian regions bordering on the Basin will continue or even be aggravated.

The second alternative, simple and rational as it may appear on paper, cannot be brought about except by reshaping the traditional ways of life of the pastoralists and their relations with the cultivators. This will call for long-range planning able to cope with very complex factors. It means, in fact, setting up a development monitoring system which will be even more difficult to realise than that of irrigated farming. Success or failure will largely depend on the programming of the pre-investment activities which are due to be carried out in the period 1980-1990.

3.3. The pre-investment programme in the stock farming sector

The purpose of this programme would be to determine institutions and methods of associating pastoral with irrigated agricultural activities, sufficiently well tested for large scale application towards 1990.

In our view, it should comprise three main components:

- A thorough knowledge of existing agro-pastoral systems and of the factors affecting their evolution.

- Development of a technology which will enable economic use to be made of by-products and fodder crops produced under irrigation, in association with rational methods of exploiting natural grazing land.

- Pilot operations to test the foregoing, with a view to developing the institutions and methods required to apply them on a large scale.

The programme's main lines would be as follows:

a) Technical socio-economic study of the pastoral system and of the grazing areas adjoining the Senegal Valley;

   - Typology of pastoral systems and identification of grazing pattern characteristic of each type.

   - Identification and analysis of factors making for change in grazing movement patterns and herd management.

   - Estimate of numbers of people involved in each type of stock farming. Other activities associated with pastoral occupations.

   - Incomes, consumption, and food habits.

b) Experimental programme to develop the optional system from the agronomic, economic and zootechnical points of view.

   - Improvement of yields (in U.F. and in protein) and methods of production of fodder crops.

   - Improvement of feed in stock farming extensive methods through use of by-products and irrigated fodder products, evaluation of their economic feasibility in a system combining breeding with milk production, and development of improved methods for fattening and feeding draught animals. Genetic improvement by selection and cross-breading.

c) <u>Pilot projects to restructure stock farming</u>

The most difficult and delicate part of a pre-investment programme, as we see it, will be to plan pilot-projects on the basis of the data obtained through the foregoing operations, which taken together should provide the macro-socio-economic and technical information needed to initiate development on a large scale.

This can only be achieved by drawing on the results of the socio-economic study previously mentioned.

We wish to point out that it is from 1985 on that the pilot-project programme can and must be launched on a large scale, since it is at that date that the Diama Dam will be completed, allowing the development of flood controlled grazing land, simultaneously with the irrigation schemes combining food and fodder crops. A programme for developing the agro-pastoral vocation of the Delta could then be put into effect, linking utilisation of the natural pasture land in the Aleg and Mederdra regions of Mauritania and of Ferlo in Senegal with the controlled-flood pastures and irrigated fodder crops of the Delta.

The object of these pilot operations would be to improve our knowledge not only of the factors influencing socio-economic, but also on those affecting nutritional constraints, since the transition from herd-management principally directed to milk production to management combining milk with stock-rearing implies that the graziers themselves will consume more cereals and less milk products.

The pilot-projects should also test different methods of making credit available to stock farmers. It will just not be possible to change from milk production on a daily basis to cattle breeding on a 2-3 year cycle without some input of credit.

Explanatory note on stock farming

In traditional stock farming herds are exploited chiefly for milk production. Meat being only a by-product, the herd is managed so as to produce a maximum of milk to the detriment of the calf-population, in which there is a high rate of mortality.

Contrariwise to a milking herd, stock-rearing aims at producing young animals which are grazed on natural pasture up to the age of 2-3 years. They are then fed intensively for several months, and this can be done by using the by-products of irrigated farming, or irrigated fodder crops. It is this final treatment which is known as "fattening" ("embouche").

In this system the milk produced goes in priority to rearing the calves, human consumption needs taking second place.

A N N E X E - E 1

TRAINING AND EXTENSION SUPPORT INVESTMENT
PROGRAMME FOR INITIAL CULTIVATION PERIOD
TO ACHIEVE A TOTAL DEVELOPMENT CAPACITY
OF 10.000 HA/YEAR IN THE MIDDLE VALLEY
(approximately 5.000 ha on each side)

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ANNEXE E 1

1. INTRODUCTION

This annexe presents an estimate of the personnel needs and minimum investment costs required to develop an overall capacity to bring 10.000 ha a year into cultivation, i.e. some 5.000 ha in Senegal and 5.000 ha in Mauritania.

Objectives of the programme

These, it may be recalled are:

- to prepare the cadres and specialists required for the functioning of each irrigation scheme, by a training programme carried out before cultivation begins.

- to provide supervisory and technical support during the first three years of cultivation sufficient to bring each scheme to a state of maximum autonomy in operation with outputs as high and uniform as possible; and to prepare them to organise highly-intensive cultivation as soon as control of the river flow makes water permanently available. This means in practice that wherever conditions allow, every scheme must be able to plant one hot-dry-season crop during the first three years of cultivation, and that a maximum area should also be cultivated during each cold-dry-season.

2. STAFFING STANDARDS FOR SUPERVISORY/TECHNICAL EXTENSION SUPPORT DURING INITIAL CULTIVATION PHASE

Length of period of intensive support: three years:

2.1. Pilot peasants: 1 pilot peasant for every 10 holdings. Each plot having on average an area of 0.75 ha (0.25 ha per worker) 1 pilot peasant will be needed for 7.5 ha (1).

2.2. Grassroot extension staff: 1 extension worker per 100 ha (say 1 for every 13 pilot peasants) this being equivalent to 1 extension worker for each village scheme, or village section on a large scheme.

2.3. Specialists

. Pump operators - For small schemes only: 1 operator per 50 ha (= 2 operators on a village scheme of 100 ha)

Breakdown mechanics - We recommend, for the repair of pumps, outboard motors and vehicles, training breakdown repair mechanics who will be re-integrated in the local milieu and will be allocated an irrigated plot. Whilst cultivating this holding (or having it cultivated) they will be able to carry out running repairs on motorpump assemblies on small schemes, say 1.000 ha.

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(1) We have adopted the ratio of 1 pilot-peasant to 10 farmers in the light of a number of sociological observations, concerning notably the size of extended families (gallés), clan relationships, and the size of the sub-groups which came spontaneously into being when producer-groups on large-scale schemes broke up.

. Mechanics for pumping stations on large schemes

4 per 1.000 ha.

. CUMA (or development corporation) mechanics

4 per 1.000 ha.

Tractor drivers - 2 per tractor, 1 tractor per 50 ha., 40 per 1.000 ha.

. Village community irrigation wardens - 1 for each village irrigation scheme or village section of a large perimeter, say 1 per 100 ha.

. Co-operative cadres - 1 per village scheme or village section of a large scheme, say 1 per 100 ha.

2.4. Senior cadres

1 extension agronomist per 1.000 ha.
1 irrigation engineer per 2.000 ha.
1 expert in agricultural machinery per 2.000 ha.
1 expert in co-operatives per 2.000 ha.

Of this total number, the following will be phased out after three years and will again be available for staffing new schemes coming into first cultivation:

Grassroot extension staff: all
senior cadres: 1 agronomist in 2
All other experts.

3. STAFFING STANDARDS WHEN "NORMAL" PHASE OF CULTIVATION IS REACHED

3.1. Local personnel not paid by development corporation

. 130 pilot peasants per 1.000 ha (1 pilot-peasant for 10 farms).
. 10 irrigation wardens for every 1.000 ha.
. 1 pump breakdown-repair mechanic per 1.000 ha on small schemes.
. 4 CUMA repair-mechanics per 1.000 ha.

3.2. Development corporation personnel (1)

. 1 agronomist per 1.000 ha.
. 1 monitor per 1.000 ha (middle grade cadre directly recruited, or selected from grassroot extension staff).
. 1 pump-repair workshop with 4 mechanics for each 5.000 ha (+ 1 expert for three workshops).

(1) Administrative and maintenance personnel on the large schemes, and the major workshop or workshops for tractors and agricultural machinery, are not included in this list.

4. PROGRAMME AND COST OF PRELIMINARY TRAINING PRIOR TO YEAR WHEN CULTIVATION IS BEGUN, FOR AN ANNUAL DEVELOPMENT CAPACITY OF 10.000 HA (5.000 IN MAURITANIA, 5.000 IN SENEGAL)

4.1. Training of pilot-peasants and basic extension staff

4.1.1. Pilot-peasants

Total number to be trained each year:

(1 for every 7.5 ha): $\frac{10.000 \text{ ha}}{7.5} = 1,333$

These pilot peasants are chosen by their village community during the construction phase of the irrigation scheme. Thus a contractual relationship is implicitly established between the pilot-peasant and the community, which undertakes the levelling and preparation of his plot whilst he is acquiring the new technology on behalf of the community. This being so, there is no provision for supplementary training to take care of possible wastage, each community having made its specific arrangements, if these break down the members of the group which made a bad choice will have to pick up their knowledge from other pilot peasants on their scheme.

Length of training: 1 year, three crop seasons, 1 in the rainy season, two in the dry.

4.1.2. Grassroot extension staff

Total number to be trained each year: (for 3 years only, given that the basic grade staff on each scheme will be switched over at the end of 3 years to start extension work on new schemes).

- in the proportion of 1 extension worker per 100 ha.

$$\frac{10.000 \text{ ha}}{100 \text{ ha}} = 100 \text{ extension workers}$$

Length of training: two years, the first being combined with that of the pilot peasants, whilst in the second they will act as assistants to the instructors on the training perimeters.

Recruitment: We recommend that these workers be recruited in rural areas (or small towns) in each region, from candidates who can read and write.

Wastage: 20% wastage is allowed for.

Taking wastage into account, the total number of extension workers to be trained is 120 annually during the period of three years.

4.1.3. Training perimeters (or training sections on large perimeters)

The pilot-peasants and first-year trainee extension workers will be trained on certain training perimeters or sections on which cultivation will be organised so as to provide a model for the organisation of small irrigation schemes or village sections of large perimeters. The pilot-peasants and trainees will be grouped in teams of three to cultivate the equivalent of a peasant holding of 0.75 ha. The collective decisions concerning organisation and exploitation will be taken after collective discussions led by the instructors.

Second-year trainee extension workers do not work on a holding, but act as assistants to the instructors.

Acreage of a training perimeter

Acreage for pilot-peasants 1.333 x 0.25 ha	= 333 ha
Acreage for first-year trainee extension workers 120 x 0.25 ha	= 30 ha
Total acreage of training perimeters for an extension capacity of 1.000 ha	363 ha

Or a total of two training perimeters (one on each bank of the river) of 100 ha and two training sections on large perimeters (one on each bank) of 100 ha each.

4.1.4. Annual budget of a training perimeter or training section of a large perimeter

2 experts (expatriate) 2 x $70.000	$ 140.000
10 instructors (1/3 expatriates) 10 x $15,000	150.000
Perimeter operating costs (50.000 F x 100ha equals 5.000.000 F CFA)	20.000
Miscellaneous	50.000
Total annual budget per training perimeter	$ 360.00

Notes: It is assumed that at the beginning the two experts (one an extension agronomist, the other an organisation and management expert) are expatriates; subsequently these costs will be reduced by training local cadres.

As to the instructors, it is assumed that one-third will be recruited from extension workers or trainers in countries with a tradition of irrigated rice farming (Korea, China, Thailand, Philippines, Madagascar, etc.) and 2/3 (perhaps 12 for each country) chosen amongst extension workers from member states who have good experience of irrigated farming practice.

The pilot-peasants and first-year extension worker trainees are not paid a wage; instead they receive the product of their crops, the cash cost of inputs is paid by the development corporation (this is taken into account in the annual budget under the heading "Operational Cost" for which the sum of 50,000 F CFA is earmarked).

4.1.5. Cost per head of training pilot-peasants and first-year extension workers

$360.000 to train 324 pilot-peasants and 25 extension workers (wastage not included) = $1.030 per pilot-peasant or extension worker.

Cost of training a pilot-peasant in terms of cost per hectare.

$$\frac{\$1.030}{7.5} = \$138$$

Cost of training an extension worker

- First year $1.030
- Second year 2.000
  Total $3.030

The second-year cost represents the maintenance grant paid to extension workers ($1.800 plus 10% for wastage in 2nd year).

Cost of training an extension worker in terms of cost per hectare

A basic grade extension worker serves on a perimeter for three years, and is then transferred to another. For a development capacity of 10.000 ha 100 extension workers must be trained every year for 3 years (120 allowing for 20% wastage) or 300 extension workers at a total cost of $2.030 x 300 = $609.000.

We estimate that this investment can be written off over 10 years, equivalent to an annual charge of $61.000.

The training cost per hectare can thus be expressed as:

$$\frac{\$61.000}{10.000} = \$6/\text{ha}.$$

4.1.6. Amortisation of training perimeters

The costs of establishing them are:

. Preparation and equipment of 200 ha in two perimeters 22 x 2.000 =	$400.000
. Preparation and equipment of 200 ha on large perimeters 200 x 6.000 =	1.200.000
. Living quarters for experts and cadres =	2.000.000
. Pilot-peasants' quarters (dormitories)=	2.000.000
. Vehicles	200.000
. Miscellaneous plant and equipment	200.000
Total cost of training perimeters	$5.000.000

Allowing 15 years to write off these costs, the annual amortisation charge amounts to:

$$\frac{5.000.000}{15} = \$\ 333.333$$

Expressed in cost per hectare, this becomes:

$$\frac{333.333}{10.000} = \$\ 33.3/\text{ha}$$

4.2. Training of pump-operators

4.2.1. Cost of training

Out of 10.000 ha brought into cultivation each year, it may be supposed that 5.000 ha will be in small village schemes or medium-size schemes of 200-300 ha, each with several motorpump sets.

On the assumption of 1 pump-operator for 50 ha it would be necessary to train 100 a year, or, counting a 6-months' training period, 2 courses a year each of 50 operators. Allowing for 20% wastage this means training 120 operators a year, or in batches of 60.

Operational cost of a training center for pump-operators

. 1 expert (expatriate)	$ 70.000
. 6 mechanic-instructors	90.000
. Working costs	200.000
. Maintenance grants for trainee operators (1.800 x 60)	108.000
Total cost of training 100 pump-operators:	$468.000
Cost of training 1 pump-operator	$ 4.680
Training cost per hectare: $\frac{468.000}{5.000}$ =	$ 93.6/ha

4.2.2. Amortisation charges for pump-operator training centre

4.2.2.1. Cost of establishing centre

Living quarters	$ 800.000
Buildings	800.000
Plant and equipment	800.000
Total	$ 2.400.000
Write-off period - 10 years	
Annual write-off charge	240.000

Amortisation charge per hectare:

$\frac{240.000}{5.000}$ = $ 48/ha.

4.3. Training of maintenance mechanics for pumping stations on large perimeters

On the assumption that these mechanics are recruited from graduates of member-state technical colleges, their training will be limited to a 6-months' course on an operational pumping station.

Cost: 6 months' salary: $600 x 6 = $3.000
Cost per hectare (4 per 1.000 ha) $\frac{3.000 \times 4}{1.000}$ = $12/ha

4.4. Training of pump breakdown repair mechanics for small perimeters (who will later be set up to work on their own account)

They will be trained in the training centre for pump-operators, but for 12 months instead of 6.

Number to be trained (allowing for 20% wastage) - 6 for 5.000 ha. of small schemes.

Cost of training 1 breakdown mechanic (twice the cost of training an operator): $4.680 x 2 = $9.630 or $9.6 per hectare.

4.5. Training of mechanics for repair workshop serving small perimeters

Same recruitment, training and cost as for pump station mechanics on large perimeters.

Cost: $3.000 per mechanic
Number: A team of 4 mechanics for 50 perimeters, or 4 for 5.000 ha.

Cost per hectare: $\frac{4 \times 3.000}{5.000}$ = $2.4/ha

4.6. Training of irrigation wardens

4.6.1. Cost of training: Total number to be trained annually: 100 or 120 allowing for wastage (20%)

Length of training: 6 months

They will be trained on neighbouring training perimeters or training sections of large perimeters.

Annual operational budget of irrigation wardens' training centre

. 1 expert (expatriate)	$ 70.000
. 4 instructor cadres (I.T.A.)	60.000
. 120 maintenance grants (120 x 1.200)	144.000
. Miscellaneous expenditure	100.000
Total cost for 100 irrigation wardens	$374.000
Cost per irrigation warden	$ 3.740
Expressed as cost per hectare	$ 37.40/ha.

4.6.2. Amortisation charges

Cost of setting up training facilities for irrigation wardens

. Living quarters	$ 800.000
. Buildings	200.000
. Vehicles and miscellaneous equipment	200.000
Total cost of establishment	$ 1.200.000
Length of write-off period: 10 years	
Annual write-off charge:	$ 120.000
Cost per warden/per hectare:	$ 12/ha.

4.7. Training of co-operative cadres

4.7.1. Cost of training

Number of cadres to be trained annually: 100
Add 20% wastage: total 120
Length of training: 6 months
(2 courses of 60 each year).

Training centres' annual budget:

. 1 expatriate expert	$ 70.000
. 2 local experts	30.000
. Maintenance grants (120 x 1.200)	144.000
. Miscellaneous expenses	100.000
Total (100 cadres)	$ 344.000
Cost per cadre	$ 3.440
Cost per hectare of co-operative cadres	$ 34.40/ha.

4.7.2. Amortisation charges

Cost of setting up training centre for co-operative cadres

. Living quarters	$ 800.000
. Buildings	200.000
. Vehicles and miscellaneous equipment	200.000
Total cost of establishment	$1.200.000
Length of write-off period: 10 years	
Annual write-off charge:	$ 120.000
Amortisation cost per hectar:	$ 12.00/ha.

4.8. Training of tractor drivers

For annual development capacity of 5.000 ha of large-scale perimeters 200 tractor drivers have to be trained.

Length of training: 2 months or 6 courses of 37 (allowing 20% for wastage).

4.8.1. Training costs

Annual training budget:

. 1 expert	$ 70.000
. 8 instructors ($15.000 x 8)	120.000
. Operating costs	400.000
. 220 Maintenance grants (400 x 220)	88.000
Total:	$678.000

. Training cost per tractor driver:

$$\frac{\$678.000}{200} = \$\ 3.390$$

Cost of training tractor drivers, per hectare = $ 135.6/ha

4.8.2. Amortisation of cost of setting up tractor drivers' training centre

. Amortisation of 10 tractors over 5 years:

$$\frac{\$1.000.000}{5} = \$\ 200.000$$

. Buildings $\frac{\$1.600.000}{10}$ = 160.000

Total annual amortisation charge $ 360.000

Annual amortisation cost per hectare:

$$\frac{\$360.000}{5} = \$\ 72/\text{ha.}$$

4.8.3. Training of CUMA mechanics

Same cost as for training pump repair mechanics, i.e. $9.360/mechanic

Cost per hectare: $\frac{\$9.360 \times 4}{1.000}$ = $37.44/ha.

(These mechanics will be trained at the tractor-drivers' training centre.)

4.9. Recapitulation of preliminary training costs expressed as cost/hectare

Training costs (in $)	Small Schemes	Large Schemes
Pilot peasants	138	138
Basic grade extension workers	6	6
Pump operator	93.6	-
Pumping station mechanics	-	12
Pump breakdown repair mechanics	9.4	-
Pump repair workshop mechanics	2.4	-
Irrigation wardens	37.4	-
Co-operative cadres	34.4	34.4
Tractor drivers	-	135.6
CUMA mechanics	-	37.4
Sub-total - training costs	321.2	363.4
Amortisation cost of training facilities		
Training perimeters	33.3	33.3
Training centre for pump operators	48	-
Training centre for irrigation wardens	12	12
Training centre for co-operative cadres	12	12
Training centre for tractor drivers	-	72
Sub total - Amortisation charges	105.3	129.3
Total cost per hectare	426	493

5. Programme and cost of extension and support during first three years of cultivation for an annual development capacity of 10.000 ha. (which means that each year there will be 30.000 ha under intensive extension and support).

30 expert/years (instructional, for diffusion of new techniques) 1 per 1.000 ha. comprising:

10 years, expatriate experts	$ 700.000
20 years, local experts	400.000
300 years, basic grade extension workers (1 per 100 ha) 300 x 3.000 =	900.000
15 years, irrigation engineering experts (1 per 2.000 ha) of which 5 years will be expatriate experts	350.000
10 years local experts	200.000
15 years, organisation and co-operatives experts (1 per 2.000 ha) consisting of:	
5 years, expatriate experts	350.000
10 years, local experts	200.000
Operating and amortisation costs of vehicles (automobiles , mopeds, boats)	600.000
Amortisation (over 10 years) of maintenance grant costs of training 50 local experts $\frac{20.000 \times 50}{10}$	100.000
Total cost of providing extension and support on 10.000 hectares for three years:	$4,350.000
Cost of this support per hectare:	$ 435/ha.

6. Total investment cost of training and technical support to bring schemes into cultivation

. Per hectare, large irrigation scheme:	$928/ha
. Per hectare, small irrigation scheme:	$861/ha

7. Cost of subsequent extension and support after first three years of bringing irrigated land into cultivation

For 10.000 hectares:

. 5 man/years of agronomist-instructors (1/2.00 ha)	$ 100.000
. 10 man/years of monitors (1/1.000 ha)	120.000
Total cost of this support for 10.000 ha.	$ 220.000

Annual cost per hectare: $22 or equivalent of 110 kg of paddy.

Cost per crop (intensification coefficient of 2):
$11 or equivalent of 55 kg of paddy.

8. Maintenance cost of pumps on small irrigation schemes

This cost (maintenance and breakdown repair) comprises two elements, one being the use of the breakdown repair mechanics working on their own account and who have been trained and set up as mechanics/cultivators, the other being resort to the development corporation workshop staffed by 4 mechanics. Each workshop serves 50 schemes of 100 ha. (an average availability in the year of 16 mechanic-days for a scheme, or 8 for a pump).

Workshop's annual operational budget:

. 4 months, expatriate expert	$23.300
. 4 years, mechanics	36.000
. 4 assistant mechanics	12.000
. Travel costs (1 pirogue, 1 cross-country vehicle plus drivers and depreciation)	42.000
. Equipment depreciation charge	5.000
. Miscellaneous general expenses	10.000
Annual cost of repair and maintenance workshop	$ 128.300
Annual cost of breakdown repairs, per hectare:	$ 25.7/ha.
Annual cost per hectare/crop:	$ 13.0

To these figures should be added the cost of calling on the services of the breakdown repair mechanic which we estimate at $250 (50.00 F CFA) a year for each irrigation scheme, or $2.50 per year per hectare or $1.27 per ha/crop.

Total cost of maintenance is thus about $27/ha/year excluding spare parts. These have been estimated by SICAI, on the basis of a follow-up carried out on 11 existing schemes of 10-20 ha. at 4.300 F CFA ($21.5) per hectare/crop.

The cost of spare parts, expressed per hectare, will be much less on new schemes with an average area of 100 ha.

9. Recapitulation of qualified personnel needs for an annual development capacity of 10.000 hectares

9.1. Expatriate experts:

9.1.1. For training

- 8 extension agronomists to train pilot-peasants.
- 1 mechanical engineer to train pump operators
- 1 irrigation engineer to train irrigation wardens
- 1 management expert to train cadres for co-operatives
- 1 agricultural machinery expert for training centre for tractor drivers.

9.1.2. Supervisory technical support for initial period of cultivation

- 10 agronomist-instructors
- 5 irrigation engineers
- 5 agricultural machinery experts
- 5 management experts for co-operatives

9.1.3. TOTAL of expatriate experts: 37

9.2. Local experts

9.2.1. For training

- 40 trainers for pilot peasants (recruited from existing staff of monitors plus six months' training course at ADRAO, or training course "on the job")
- 6 mechanic-instructors for pump-operator training centre (diplomas from State technical schools plus 6 months' training).
- 4 pumping station mechanics (technical school diplomas, plus 6 months' training at a pumping station).
- 4 mechanics for pump repair workshops for small irrigation schemes (technical school diplomas, training at pump operators training centre).
- 4 training cadres for irrigation wardens (middle grade agricultural technicians - ITA (ingénieur des travaux agricoles) or works foremen plus 6 months' training course abroad).
- 2 experts in co-operatives training (ENEA (Senegal) or CFVA (Mauritania) diplomas plus 6 months' training abroad).
- 8 instructors for the tractor-drivers training centre (technical school diplomas plus 6 months training abroad).

9.2.2. Extension and support for initial period of cultivation.

- 20 extension agronomists (agronomic engineers plus 12 months' training course at ADRAO or IRRI).
- 10 irrigation engineers (irrigation or public works engineers plus 12 months' training abroad).
- 10 co-operatives experts (commercial or ENEA or GFVA diplomas plus 12 months' training abroad).
- 10 agricultural machinery experts (mechanical engineers plus 12 months training abroad).

9.2.3. Total of local cadre needs

- Senior cadres	30
- Senior or middle grade cadres	26
- Basic grade cadres (monitors)	40
- Industrial cadres (mechanics)	22

9.3. Annual needs for qualified personnel for permanent technical support after first three years of initial cultivation on each irrigation scheme

After these first three years the only qualified personnel to be employed will be local.

- Extension agronomists (chosen amongst those who have had three years' experience in providing technical support during the period of initial exploitation).
- 10 middle grade agricultural technicians
- 8 mechanics (for pumping stations and small irrigation schemes' repair workshop).

NOTE: This list does not include administrative and maintenance personnel responsible for the primary and secondary irrigation networks on each large scheme.

ANNEXE E 4

SOME SUGGESTIONS FOR AGRONOMICAL EXPERIMENTS IN 1980-81 IN THE REGION OF SAME KAYES (AND IN THE FRAMEWORK OF THE OMVS IRRIGATED FARMING PROGRAMME (1)

(1) Ton That TRINE, July 1979

I) Rainfed crops with supporting irrigation (in rainy season)

A. - Food crops:

1. Sorghum: Since 1976 ICRISAT's sorghums (74.102-43-2B for example) have shown themselves to be superior to other varieties such as SIO and CE90, with a potential of more than 4 t/ha.

2. Penicillate millets:

M2 D2 long-strawed millet
Souna 3/4, 3/4 HK, 3/4 Souna; 3/4 Ex-Bornu for dwarf millets.

3. Maize: JDS (Sefa yellow) superior to Zanguerini. No further comment on these rainfed crops, in view of the excellent collaboration with ICRISAT, SAFGRAD/MALI, IRAT, IRCVC, which should be continued in the future.

4. Wet-season rice with supporting irrigation:

The varieties tested at Kaédi and made available to Samé-Kayes have confirmed their characteristics; IR 36, IR 1561-228-3, Jaya and IR 1529-680 (yields of 6 to over 8 tonnes/ha on large holdings). These varieties, with such yields, are suited only to heavy land (medium heavy and heavy clays) at Kamenkolé, not to the light soil of Samé.

And so in 1979 some varieties of "upland" rice ("hill rice" as it is called in Africa) were introduced on light soils, not flooded (not "aquatic") but with a little help from irrigation. Two varieties amongst several hundreds tried out seem to show promise. "Upland" varieties would also economise water (hence also a lesser need for inputs).

"Aquatic" rice can be cultivated without urea (industrial nitrogen) an input which is expensive in Mali by comparison with the official price of paddy.

either: by the Spirilium and cellulolytic and pectinolytic bacteria in the Dapog nursery (already well assimilated to the Kamenkolé Station).

or: by the azolles (sown between the rows of rice) which are to be tried out at Samé-Kayes on "aquatic" rice varieties (IR 36, IR 1561-228-3, Jaya, IR 1529-680) as has been done this year at Kaédi. This technique of sowing azolle would enable yields of the order of 6-7 tonnes to be obtained without urea as in China and Vietnam, with upstanding modern varieties, and would thus make irrigated rice farming in Mali an economic proposition.

B. - Food legumes (pulses)

1. Cowpeas: Tried out in rainfed cultivation some IITA varieties at Samé have given more than 3 t/ha of dried grains. With supporting irrigation at Guédé they have produced more than 4.5 t/ha. These experiments with date of sowing and use of supporting irrigation should be continued with cowpeas, which are a type of pulse much appreciated in the Sahel.

2. Angole peas: This is a semi-perennial double-purpose plant (fodder and grain), resistant to drought and high temperatures but producing grain in the cold dry season (January-February). It should be more actively rotated with sorghum, maize, and even rainfed rice (to conserve soil fertility) and the present range of samples should be extended. It can also be harvested in its green state, as the peas can then be canned like green peas.

3. Soya beans: Present studies, apart from the testing of different varieties in methods of cultivation and inoculation (rhizobium japonicum), should be continued. Soya is a possible export crop to Europe.

4. Groundnuts for oil and for direct consumption (as peanuts):

For oilmilling: work on disease-resistance, study of fertilisation problems, add to the range of varieties collected and complete present series of trials of them.

For table nuts: The yield in pods of certain Florida varieties is more than 4 t/ha in rainfed cultivation. Improved methods of cultivation should be tried with supporting irrigation to achieve yields of 6-7 t/ha with these varieties, as are obtained in Florida.

II) Irrigated crops in the dry season

A. Food crops

The climate of the Valley in the cold dry season is very suitable for the following food crops: sorghum, maize.

1. Sorghum: Given high productivity of sorghums crossbred on the local varieties, the policy should be to steer research towards these crossbred varieties and their production as seedstock locally. Birds as predators of sorghum are a major problem, not to be overlooked in research on dry-season irrigated sorghum.

2. Maize: There is of course a case for continuing work on the synthetics and composites, but their productivity does now seem to have peaked out. It would be advisable to take up instead the study of new forms of hybrids, but the production of seedstock on a scale large enough to promote widespread cultivation by the peasants will also need more intensive research and follow-up.

3. Corn, Triticales, Hard Wheat: The yields obtained at Samé are not yet good enough (1.5 to 2.8 t/ha on large holdings) to justify a campaign to increase sowings. Consideration should be given to shifting the direction of research into these substitute cereals to verify the recommendations based on the Guédé results.

Efforts to economise inputs (pumping, hence lubricants or gasoil, fertiliser, pesticides, etc.) should now be made on a bigger scale than earlier at Kaédi and Guédé, in view of the high cost of inputs in Mali in relation to the prices paid to producers of cereals.

III) Other possibilities

A. Cultivation of cassava (with supporting irrigation)

The European market (Germany, Netherlands, Denmark) imports 5 million tonnes of dried cassava roots a year, chiefly from Thailand, and this could become 10 million if no protectionist measures to defend the potato are introduced. Africa can take a share in this export trade, provided the necessary steps are taken to develop new methods of cultivation. From the angle of plant varieties, there have recently been some technological breakthroughs at CEAT (Colombia) and to a lesser degree at IITA (Ibadan). For example, peak yields of 25-26 t of dried product/ha (= more than 58-60 t of tubers with little input have been obtained. In Africa, leaving aside questions of productivity, there are 3 serious constraints:

- Virus disease (mosaic of cassava)
- Bacterial withering
- Mealy bug infestation, particularly in Senegal.

It is thus not possible to go ahead quickly by importing cuttings of the most productive clones from Latin America or Ibadan (IITA), since the cuttings may contain disease germs or insects. It would be necessary to make a selection locally from disease-free hybrid seeds. A 5-7 year research programme carefully followed through on cassava selection would enable methods of cultivation to be developed, suited to the light soils of Samé with supporting irrigation, and could prove to be profitable by way of exports of dried cassava roots. Unlike cereals, cassava is a crop requiring only a small amount of inputs. A study of "V.A." mycorhyzas may lead to economies in the application of phosphated fertiliser to cassava.

B) Sugar cane

The soils of Samé-Kayes, light and non-saline by comparison with Richard-Toll, may offer some advantages for irrigated cultivation of sugar cane in this region.

C) Irrigated long-staple cotton (Sudanese and Egyptian type) or even medium staple (American type).

Mali normally gives priority to rainfed cotton production in association with food crops in the Southern regions. But as irrigation becomes available, it will be worthwhile to resume the studies of irrigated cotton which have been abandoned during the last three years for want of means. Irrigated cotton can give yields exceeding 4 t/ha of cotton seed (on experimental plots).

D) Fodder crops(especially pulses) adapting well to the light soils of Samé

Amongst these are perennial lucerne (Medicago sativa) and the varieties of annual lucerne (Medicago truculata, Medicago littoralis, etc.) rotated with cereals and perennial Stylosanthes (guyanensis, hamata, etc.). Even annual Stylosanthes (humilis) could be of interest in the rainy season in association with local graminaceae grown on adjacent light and medium-light clay soils. Local Lotus arabiens and Trigonella Sp are also of interest.

The current study of specific rhisobiums of Stylanthes and of Medicago undertaken at ORSTOM-Dakar (and experiementally at Kaédi) could be most helpful to these fooder crops at Samé. If the use of draught animals for cultivation is to be developed in this region, there must be a link between stockfarming and irrigated crops. And indeed, it appears that the Minister for Rural Development in Mali has in mind to amalgamate the Agronomic Station at Samé with the stockrearing station projected to be established some 30 km to the North.