

# Water buffalo technology in northern Senegal

Report of a consultancy mission to review harnessing and implements  
for use with water buffaloes in Senegal

Prepared for

USAID-Dakar  
and

Projet d'Introduction de Buffles Domestiques au Sénégal,  
Ferme de Makhana, Saint Louis, Sénégal

*by*

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## Four relevant quotations

“The water buffalo, with its tolerance for heat, disease, poor-quality feed, and mismanagement, appears to have outstanding promise for African nations such as Sudan, Tunisia, Senegal, The Gambia as well as all nations south of the Sahara (Namibia perhaps being an exception).”

*Conclusion in “The water buffalo: new prospects for an underutilized animal”  
(Bostid, 1981)*

“Can you see the good points and the bad points of [this man],  
and can you live with the good and the bad points together?”

*From a traditional wedding ceremony*

“Well, it would be best not to start from here.”

*Legendary response to request for directions in Ireland*

“The work has provided some very valuable and fundamental lessons:

The need to involve and consult with the end-user (farmer)  
at all stages in planning and implementation.

The great danger of developing inappropriate solutions if research is undertaken in unrealistic conditions, if domineering (top-down) research philosophies are adopted or if criteria are based on maximising technical efficiency rather than appropriateness to the needs of the farmers

The dangers of aid agencies, international centres and national programmes using their considerable influence and resources to promote through publications, subsidies, credit and gifts, inadequately evaluated technology.

The significant effect that over-optimistic reporting or misinterpreted terminology can have in promoting a technology to individuals and organizations anxious to achieve quick, visible results.

The importance of regarding “negative lessons” as potentially valuable.”

*Conclusion of “Perfected yet rejected” by Paul Starkey, 1988*

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# Executive summary

A mission was undertaken in June 1990 to advise the USAID-supported "Projet Buffle" on suitable harnesses and implements for use with water buffalo in northern Senegal, and to comment on the potential for artisanal production using locally-available resources.

The consultant reviewed the situation using a farming systems perspective, and noted that the project had started as a result of USAID-enthusiasm for water buffaloes, rather than any problem identification at farm level. Buffaloes were now a "solution" in need of an appropriate "problem". Widespread misunderstandings were evident concerning water buffaloes in Asia and Africa. While buffaloes are excellent for swamp cultivation, far more oxen are used in the rice fields of Asia and Egypt than buffaloes. Most attempts at water buffalo introduction in Africa have failed due to disease or lack of significant advantages over alternative species. No records exist of buffaloes on smallholdings in sub-Saharan Africa.

The first phase of "Projet Buffle" demonstrated the viability of buffaloes under high management in Senegal. The second phase is attempting to introduce draft buffaloes into farming systems in the "Delta" and "Fleuve" (Senegal river valley). Two key organizations, ISRA and SAED, consider there is little need for draft animals in rice production systems in the Delta. A productive, profitable system involving tractors exists and is almost universally used. Affordable mechanical power is not a limiting factor at present. ISRA, SAED and several projects saw a role for animal traction in rice production systems in the Fleuve. Farmers verified this. The Fleuve has a very hot, dry climate likely to cause stress for buffaloes with poor thermoregulation.

Oxen are more adapted to this climate: they are affordable and available and appear capable of performing rice cultivation operations. Over 600 oxen were trained in the Fleuve last year. Steel implements made by SISMAR appear acceptable for rice cultivation and can be maintained by local blacksmiths.

Projet Buffle has planned to introduce a novel species and a new management system to farmers unfamiliar with animal traction technology. It planned to combine this with an unproven harnessing system and prototype equipment. Introducing multiple variables is neither necessary nor desirable. Buffaloes can be evaluated using existing SISMAR implements. Well-proven yokes should be used in preference to innovative harnesses. By using double yokes, buffalo pairs will have a potential draft power output advantage over ox pairs. The present use of single buffaloes negates this advantage.

The market for buffalo-drawn implements is negligible. Implement design and manufacture is unlikely to be a limiting factor to buffalo introduction. The project has few comparative advantages in this area and so it should encourage other organizations to test and develop implements for oxen; these could also be used with buffaloes.

In view of the uncertain prospects for economically viable buffalo adoption in Senegal, the project should immediately start to work with research organizations to collect valuable data, including comparisons between oxen and buffaloes. The publication of a well-documented case history should be an essential project output.

# Preface and Acknowledgements

This report was prepared during sixteen working days in Senegal. During this time the consultant was based at the Makhana farm, headquarters of “Projet Buffle”. He travelled widely with project staff in the “Delta” and “Fleuve” to have discussions with farmers and other agricultural experts. The consultant is greatly indebted to the project staff and to all farmers, researchers, development workers and artisans who gave up their time to provide information, and he hopes he has adequately presented their views in this report.

The consultant is only too aware of the dangers of external people, such as himself, coming in and making pronouncements about project achievements and the needs of farmers, when time has been too short to appreciate and understand the complexity of the local farming systems and the various pressures on the organizations involved in agricultural development. The consultant therefore wishes to apologize in advance, should anything he say appear to be inaccurate or unfounded: this was certainly not intentional, but clearly time was too short to obtain a comprehensive understanding of past events and present realities.

The consultant is also well aware of the danger of appearing to be over-critical. It is very galling for someone struggling to solve a problem (or to train a buffalo or make a plow) to have someone stand on the sideline and, with the unfair expertise of hind-

sight, say it should have been done another way. Nevertheless one object of this mission was to provide alternative suggestions and point to possible improvements. If this involves criticism, then it is intended to be constructive criticism. This should be taken positively for it does not imply any lack of appreciation for the time already spent and the work already done. The consultant is very well aware of the time, money and effort people have invested in the project so far, and is very appreciative of what has been achieved to date. His aim in any constructive criticism is simply to provide alternative ideas that might maximise the benefits of previous efforts, and improve the relevance, value, efficiency and impact of present and future initiatives.

The consultant wishes to express his thanks to all those who facilitated his mission. The initiative came from staff of USAID, Dakar. Tropical Research and Development Inc. of Gainesville, Florida, arranged for the services of the consultant to be provided. Projet Buffle provided local logistical support. Particular thanks go to Dr. Yoro Ba, Acting Director of Projet Buffle, and to Joseph Howell, Animal Traction Specialist of Projet Buffle. These two colleagues arranged all field visits and meetings, provided transport and accompanied the consultant in his quest for information. The consultant wishes them, and their other colleagues, well.

# Introduction and scope of the report

This report derives from a consultancy visit, carried out from 28 May to 16 June 1990, to the *Projet d'Introduction de Buffles Domestiques au Sénégal* ("Projet Buffle") based at Makhana, near Saint Louis. Makhana is in the "Delta" of the River Senegal, and the river for much of its length forms the northern border of Senegal, at its frontier with Mauritania. The river valley is known as the "Fleuve".

The visit was funded by the United States Agency for International Development (USAID) through a contract arranged between USAID-Dakar and Tropical Research and Development Inc., of Gainesville, Florida, USA.

The object of the visit was to provide technical advice relating to harnesses and implements for water buffaloes in northern Senegal. The consultant, in consultation with the Government of Senegal, USAID officers, staff of *Projet Buffle* and local agencies, was expected to conduct a study and prepare a report analysing designs and sources of animal traction implements and equipment and prospects for implement manufacture in the Senegal River Delta and Valley (the "Delta" and "Fleuve"). The study was to be achieved through review of available literature, examination and field trials of implement prototypes, and through interviews with farmers, metalworkers, agricultural researchers and government officials.

It was expected that the consultant would provide guidance on the type of plows and implements that could be used for swamp rice production. He was also expected to report on whether wooden implements should be developed, whether local artisans had the necessary skills to make and repair animal traction implements and what harnessing systems were appropriate for buffaloes.

The mission was not an evaluation. It is therefore beyond the scope of this report to discuss in any detail the planning, design, implementation and evaluation of the first phase of the project, and the planning and implementation of the second phase. It is the view of the consultant that the project, USAID and the Government of Senegal would all benefit from a thorough, searching and objective review of the project since its inception, as this would yield some valuable lessons which would help to maximise the benefits of the project. However, since the scope of this present mission was limited to one particular area of project activities, the issues discussed in this report will be only those directly relevant to the terms of reference of the present assignment. Some background information on the project will also be presented so that the current work relating to implements can be seen in an historical and geographical perspective, as well as in the context of existing farming systems and other development initiatives.

# Background to Projet Buffle

Projet Buffle is a highly innovative project. It did not originate from any grass-roots, farmer-inspired development initiative or from a Government of Senegal (GOS) planning exercise. Rather it is readily acknowledged by staff of both USAID and GOS that the original concept and early motivation for the Projet Buffle came from USAID in the early 1980s. The idea for the project can be traced back to the USAID-funded publication entitled “The water buffalo: new prospects for an underutilized animal” (BOSTID, 1981). This was prepared by an Ad Hoc Panel of the Advisory Committee on Technology Innovation of the Board on Science and Technology for International Development (BOSTID) of the US National Research Council. The Ad Hoc Panel included several distinguished specialists and scientists. Nevertheless it is perhaps somewhat of an understatement to suggest that their report reflected more the unashamed enthusiasm of the panel for the water buffalo than any rigorous and objective scientific analysis of the available data. One recommendation of the report was:

“Testing of water buffalo production is needed in many areas where the animal is not known. . . . The water buffalo, with its tolerance for heat, disease, poor-quality feed, and mismanagement, appears to have outstanding promise for African nations such as Sudan, Tunisia, Senegal, The Gambia as well as all nations south of the Sahara (Namibia perhaps being an exception).”

The report also gave information on the “initial success” of water buffalo introductions onto research stations in Uganda, Tanzania and Nigeria. (It may be noted that the BOSTID report did not refer to the various other [failed] attempts at water buffalo introduction into Africa which were cited in the more objective studies of Cockrill, 1974 and 1977).

On the basis of the BOSTID report, USAID-Dakar convinced the Government of Senegal that water buffaloes might play a valuable role in Senegal and that they were worthy of importation and investigation, within the context of a project that was to be mainly funded by USAID. USAID prepared a project proposal (Ho, undated), using information from the BOSTID publication as a justification. The project

proposal contained much of the subjective enthusiasm of the BOSTID report, but was clearly much less authoritative. The project document therefore appears to have combined selected extraction of information with a lower level of scientific objectivity, accuracy and understanding than that of the BOSTID publication. For example, it was proposed to crossbreed water buffalo (*Bubalus bubalis*) with wild Senegalese buffalo (*Syncercus caffer*), although it omitted to refer to previous [failed] attempts and did not mention that such a hybrid might be difficult to produce since these animals were not only of different species but also of different genera. The project proposal for Senegal highlighted the best qualities of all breeds of buffaloes, but did not make a clear distinction between dairy/meat buffalo (river type) and work/meat buffalo (swamp type), and so implied that the productivity of the dairy type in India, Pakistan and Egypt was in some way a justification for the introduction of swamp-type buffaloes into Senegal. The project proposal quoted the three “encouraging” experiences of buffalo introduction into Africa cited by BOSTID, but in line with the BOSTID publication, did not refer to the other experiences discussed in the standard reference works of Cockrill (1974, 1977).

The project commenced in 1986, with Dr. Souleye Diouf as Project Director, assigned by GOS, and Dan Ho (“DVM”) as USAID-funded technician. The first phase of the project had a budget of US\$757,000 with a nominal (unrealised) GOS counterpart contribution of 31,000,000 F CFA (about US\$100,000). By the end of the first phase of the project in 1987:

- renovations had been made to the Makhana agricultural station near Saint Louis, and an irrigated pasture established on dune soil;
- 20 buffaloes (14 female and 6 male) had been purchased in Thailand by project staff, and flown to Senegal;
- the buffaloes had been maintained without major problem, and had given birth to ten live calves;
- several animals had been trained (retrained) for work, and a demonstration had been given of plowing for rice production on a 0.4 ha site at



Mbarigot, close to the Makhana station.

In December 1987, USAID arranged a project evaluation (Jacob and Roosenberg, 1987), which praised general progress, but criticised various management practices. A second phase was proposed, and it was recommended that the buffaloes be maintained as a reproductive herd, but that some animals be hired out for cultivation as a form of demonstration and source of revenue. The nutritional recommendations included the elimination of rice straw from the diet and the ensiling of pasture grasses. It was recommended that a new prototype plow be developed, based on elements of the traditional Thai design and the Japanese swamp plow. It was also recommended that other implements be tested and locally manufactured, with emphasis on the Thai and Burmese comb harrows, the Malaysian rotary harrow and the Spanish puddling machine. It was further recommended to test harnessing systems, with emphasis on collar or breast band systems. Some short-term technical assistance was envisaged to assist in the research/development of implements.

The second phase started in 1988. In 1989 a second GOS-assigned veterinarian, Dr. Yoro Ba, joined the project as Deputy Director, and a USAID-appointed animal traction specialist, Mr. Joseph Howell, was recruited. By the time of the present mission in May 1990 the phase 2 achievements had included:

- Herd size had increased to 47 (30 births, two adult mortalities, one calf mortality).
- One second generation calf had been born.
- Ten animals born at Makhana had been trained to work.
- Several on-farm demonstrations had been undertaken with working buffaloes and several in-

village extension visits with slide shows had taken place.

- Contracts had been prepared for sale of animals at 50,000 - 80,000 F CFA (US\$175-285) each, subject to conditions of good management and non-disposal for four years.
- Two animals (bull and cow, both about 2.5 years, born at Makhana) had been sold and delivered to a local farmer. Several other farmers in Dagana, Podor and Matam districts were awaiting delivery of buffaloes they had bought.
- Forms had been prepared for simple data collection relating to farmer use of buffaloes.
- Two prototype plows had been locally manufactured.
- One earth-moving scoop had been locally manufactured.
- Several designs of implement had been obtained from SISMAR for testing.
- Several variations of collars and breastband harnesses had been locally manufactured and tested.

This list of phase 2 achievements is illustrative and far from comprehensive (Howell, 1989, 1990; Ba, 1990). It should be noted that during phase 2, the project decided to try to sell animals, rather than hire them out as had been suggested by the evaluators. Furthermore, the project had not followed the evaluation recommendation to remove rice straw from the buffaloes' diet nor had it attempted to make grass silage. The present consultant fully supports the project decision to ignore these evaluation recommendations, but as these issues fall beyond the scope of the present study, they will not be discussed here.



# Review of experience and field observations

## Role of water buffalo in Asia

Many people (including all the the staff of Projet Buffle and the USAID office in Dakar) are under the impression that most rice production systems in Asia involve the use of water buffaloes. It is assumed that the main alternatives to the water buffalo for swamp rice cultivation are hand hoes or power tillers. The "classic" image of the single buffalo in a flooded paddy field is considered typical of Asian rice production systems. This is not, in fact, the case, for while it is true that where swamp-type water buffaloes are owned, they are mainly used for rice production and transport, it is certainly not the case that rice production mainly involves buffaloes.

Most cultivation of rice fields in Asia involves the use of cattle, not buffaloes. There are many more cattle in Asia than buffaloes, and only in a few countries of southeast Asia, notably the Philippines, are buffaloes the dominant draft animal. Cattle can and do work in flooded rice swamps. (To illustrate this point the consultant brought with him photos of draft oxen and cows plowing in flooded paddy fields in Bangladesh, Burma, China, India, Indonesia and Pakistan). Furthermore, where buffaloes are worked in Asia, they are often yoked in pairs, a fact (again illustrated by a series of photos) of which project staff were also unaware. These two common misunderstandings would be quite justified in almost all other circumstances, but it is the view of the consultant that a project introducing water buffalo technology into Senegal should really have been better briefed from the onset of the project. Project activities might well have been different had staff realised before that cattle and buffaloes are often used in Asia in identical situations, with similar yoking systems (single or double) and *exactly the same equipment*.

## Role of water buffalo in Africa

The consultant found no evidence that people implementing or supervising the project had made any attempt to find out more about the previous examples of buffalo introduction than the information provided in the BOSTID (1981) publication. There

seem to have been no attempts to write to other projects or countries to find out about other schemes, in order to build on other people's experiences. No one seemed aware of the information provided by Cockrill (1974, 1977) which had reviewed various experiences in Madagascar, Mozambique, Nigeria, South Africa, Tanzania, Tunisia, Uganda and Zaire. In most of these cases the buffaloes (mainly riverain types) had survived and reproduced in conditions of high management, but most schemes had been abandoned as animals either died, or were neglected as having no major comparative advantage over other animals. Water buffaloes had been shown to be very susceptible to trypanosomiasis (e.g. Tanzania) and streptothricosis (e.g. Nigeria), diseases present in Casamance, but not known to occur in the Fleuve.

People implementing and supervising the present project were all under the impression that there were other buffalo-introduction programmes in sub-Saharan Africa that had been successful and that buffaloes had been used on small farms. The consultant has reviewed animal traction experiences in 48 African countries (Starkey, 1988). Water buffaloes have been used in Egypt for many years. They are mainly found in the Nile Delta and they are kept primarily for milk production. They are certainly used successfully for work, but cattle are more commonly used for work in Egypt, and it is rare to see buffalo used for work in the Nile valley, away from the Delta area.

There is one FAO-supported project situated near Mbeya, in the highlands of Tanzania, that has three male buffaloes trained for work (it had four but one died). These derive from a herd of Egyptian (dairy) buffaloes maintained under high management conditions on a government station. The present animals are owned and maintained by the FAO-supported project. The animals have been yoked in pairs and have successfully carried out some basic plowing. That project also has some Zebu oxen, and is hoping to promote the use of animal traction (mainly oxen) for irrigated rice production. The project has demonstrated that the buffaloes can do some work, but it has yet to ascertain whether they can thrive within

the farming systems of the region, and whether they would be economically viable. If the project finds that water buffalo can be used for work, there will be an outlet for the surplus male calves that are produced by the buffalo herd. However there is some scepticism as to the relevance of that water buffalo initiative, given the small numbers of buffaloes and the widespread availability of indigenous oxen.

Apparently water buffalo were maintained in Zaire during colonial days, and were used successfully for work on research stations (Cockrill, 1974; van Vaerenbergh, personal communication, 1983). David Livingstone used some buffaloes as pack animals before they died of trypanosomiasis (Cockrill, 1974). Although the consultant is unaware of any reports of this, buffaloes may well have been used for carting at the various stations where they were maintained by colonial authorities. They may also have been used in the islands off eastern Africa, such as Lamu and Zanzibar. Apart from these examples, the consultant is unaware of any other buffalo project in Africa that has used animals for work. FAO considered introducing draft buffaloes into Guinea Bissau, but it was concluded that it would be more appropriate to use the local N'Dama cattle (Smith, 1984). It is the understanding of the consultant that there are no water buffaloes in West Africa, other than those in Senegal and some individuals maintained as curiosities (e.g. in The Gambia). The consultant believes the water buffaloes that existed in Zaire, Uganda and Mozambique have died out, and that the only water buffaloes in eastern, central and southern Africa are those in Tanzania and those maintained as curiosities or in zoos.

Until the present mission, the staff of Projet Buffle did not realise just how innovative their work was: despite attempts at water buffalo introduction in several African countries, there appear to be no reports so far of water buffalo thriving and working at village level. This does not mean they will never do so, but project staff should be aware of the actual situation, so they can see their work in an appropriate context. The historical background implies the project should be taking a cautious approach rather than a "hard sell", and should be making an effort to accurately record in detail their unique experiences.

## **Comparative advantages and disadvantages of water buffalo**

In the planning and implementation of Projet Buffle, there seem to have been no detailed reviews or

analyses of the comparative advantages and disadvantages of water buffaloes and other draft animals. It might have been reasonably expected that the staff implementing or supervising Projet Buffle would have undertaken such an exercise. Comparisons between oxen and buffalo do not seem to have been even considered during the planning and implementation of the first phase of the project. In the document relating to the second phase (USAID, 1989), there is mention of oxen, and the suggestion is made (in appendix E1) that the project should concentrate on deep plowing and puddling of rice fields, since this would maximise the advantages of buffaloes over oxen. It was noted that oxen normally walk faster than buffaloes, they have similar pulling ability relative to their weight, and that cattle have advantages in availability and meat production. There was however no discussion of the great superiority of cattle in thermoregulation.

Buffaloes have many fewer sweat glands than cattle (only 10-20% the number that cattle have), and so during hot weather or during work they find it difficult to lose heat unless they wallow in water. In the hot, dry environment of northern Senegal, this is an important difference. Further there was no mention of the difference in disease resistance of cattle and buffalo, and the sensitivity of buffaloes to trypanosomiasis and streptothricosis would be of great relevance were buffaloes to be assessed in Casamance.

To date there have been no comparisons between buffaloes and cattle, in terms of work capacity in rice production systems, survival, production, reproduction, social acceptability and economic viability. Yet these are likely to be the most important comparisons that the project makes. If cattle can perform all the farming operations needed, then they are likely to be preferred in the long run, since whatever other advantages and disadvantages may be found, cattle are likely to remain more available and more affordable than buffaloes. Unless buffaloes can be shown to be technically superior to local oxen, or unless a second economic function other than work can be introduced, they are unlikely to be used for work after the initial project thrust. It would seem unfair to convince farmers that buffaloes were a superior option, if in fact oxen were a more appropriate choice.

## Knowledge of rice-producing systems in Senegal and elsewhere

The project apparently started without detailed knowledge of rice production systems in Senegal or elsewhere. There appear to have been no descriptions of rice production in the Delta and Fleuve, and the constraints experienced by farmers that might be solved by the introduction of buffaloes. The project document made vague mention of tractors and hand cultivation, but there appears to have been nothing resembling a farming systems analysis and diagnosis. Furthermore there was little detailed knowledge of the way buffaloes are used for rice production in southeast Asia, the systems of water control, the cultural operations, the timing of operations and the implement employed. The project was also unaware of the systems of rice production used in neighbouring countries such as The Gambia and Mali, or elsewhere in Africa. Thus in its initial stages the project was concentrating entirely on the animals, and it is only in recent months that it has started to gain an insight into local systems of rice production and the role draft animals have played in the past, and might play in the future.

## Experiences of ISRA

L'Institute sénégalais de recherches agricole (ISRA) has carried out many investigations relating to animal traction, but most of these relate to rainfed systems of production. The ISRA agricultural engineer presently based in Saint Louis has himself much experience of animal traction implements (Havard 1985, 1987, 1990). However he himself is currently working on motorized farming systems in the Delta. The ISRA farming systems team based in Ziguinchor has been working on farming systems in Casamance, but animal traction is currently little employed for rice cultivation (Fall, 1990; NDiamé, 1988, 1990; Sonko, 1990). The consultant was advised by USAID that it would not be appropriate to visit Casamance during the present mission.

Staff of ISRA prepared a detailed report on the farming systems of the Delta (Jamin *et al.*, 1986). The use of draft oxen for rice production in the Delta has been tried but does not now exist. In contrast, the use of horses and donkeys for the cultivation of the sandy, rainfed soils surrounding the Delta is quite common, but not as widespread as in the areas of higher rainfall to the south and east. Horses and donkeys are also widely employed for transport and in 1985 about 900 carts were in use in the vil-

lages of the Delta. There had been a scheme to introduce work oxen from 1971-73, but farmers soon stopped using oxen. They found that they could not plow hard, dry rice soils with oxen, and for this they were able to use the services of hired tractors with disk plows. With primary tillage being performed by tractors, and manual systems being employed for seeding and weeding, there appeared to be insufficient work to justify maintaining oxen, and feeding oxen during the dry season was cited as a constraint. Oxen were found to be too slow, compared with horses for them to be maintained for transport (Jamin *et al.*, 1986).

The present ISRA researchers supported this analysis. They considered that soil conditions are such that tillage with animals in dry rice fields is impractical, because of the large power requirement to penetrate and break up the soil. There is a range of soil moisture when tillage with animals is quite possible. With further moisture content (and flooding) the land becomes very difficult for animals and humans to work. Under natural rainfed conditions, the number of days when tillage with animals is practicable is small. With irrigation, such conditions can be created, provided those who control the pumps and canals facilitate this. However the Delta region has had a high level of tractor use for over thirty years, and both farmers and institutions are geared towards tractors. These operate reasonably efficiently in dry conditions on irrigated land. Many holdings are large, which favours tractor cultivation, but hire services are also available to the small farmer. Provided small farmers can rely on timely tractor cultivation at an acceptable price there is likely to be limited interest in animal traction in the Delta. It is the impression of ISRA that this is generally the case, and that the present tractor fleet (approximately 0.4 kW per hectare of irrigated land in the Delta in 1985) is adequate to cope with the demand. Tractor hire prices have recently fallen to 17,000 F CFA (c. US\$60) per hectare.

Under the present system, only one rice crop a year is grown on most of the land, and the 20% that has two crops a year often involves rice followed by vegetables such as tomatoes. Historically a second rice crop was constrained by salt water in the river, but the construction of a dam has overcome this problem. The cultivation of two crops a year will depend largely on the use of two different varieties, and effective harvesting between crops. At present

20% of rice is harvested with combine harvesters, and this is likely to increase.

The present system in the Delta produces high yields for relatively little effort. Most farmers simply carry out a rapid discing when the soil is dry. The use of mouldboard plows is rare, and some farmers do not even bother to disc their land. The land is flooded and pre-germinated seeds are distributed over the fields. There is no secondary tillage and weed control is generally by herbicide. Despite the small amount of tillage and the apparent neglect of harrowing and levelling operations, yields are high at 4-5 tonnes per hectare, so that farmers do not regard tillage as a constraint. In the circumstances it is unlikely that Delta farmers will be attracted to the use of animal traction, unless the prices of tillage and herbicide change significantly or a new farming system is developed that gives significantly higher returns. Animal traction may however be of interest to farmers in the more isolated areas of the Fleuve where tractors are not so readily available.

ISRA has been cooperating with the French organization CEEMAT in the evaluation of a single tined implement and a rolling cultivator for use in sandy soils. The equipment used to measure draft forces and animal work output might be profitably used with buffaloes. The equipment would next be in the country in July. Unless specifically requested, it would not have the capacity to measure animal temperature and respiration rate.

ISRA had already provided information to Projet Buffle, and the ISRA Agricultural Engineer at Saint Louis indicated that, provided they had adequate time and resources, members of the ISRA farming systems team would probably be happy to undertake, or assist with, relevant research relating to draft buffaloes and work oxen, and their use within local farming-systems.

## Experiences of SAED, Delta

SAED (Société Nationale d'Aménagement et d'Exploitation des Terres du Delta du Fleuve Sénégal et du Vallée du Fleuve Sénégal) has not promoted the use of animal traction in the Delta since a small scheme in the early 1970s. SAED does not consider animal traction has any important role to play in rice production in the Delta, although SAED, through projects such as Projet FED, Projet Hollandaise and Projet Matam 3, it is promoting the use of animal traction further up the Fleuve. SAED considers that the motorization experiences in the Delta have been

largely successful, and that now virtually all rice production in the Delta involves the use of tractor tillage, notably rapid discing. Through the system of dry discing, flooding and planting pre-germinated rice seed, followed by herbicide weed control, yields of five tonnes per hectare of rice can be achieved. Most farmers only crop once a year, but double cropping is likely to increase now that fresh water is available for pumping all the year. Double cropping will be facilitated by rapid harvesting with combine harvesters, and the use of varieties of different duration. While SAED does not see any major role for water buffalo in the Delta, they might possibly assist small farmers at the edge of the delta area. Animal traction, whether using oxen or water buffaloes, is more likely to be appropriate further up the Fleuve.

SAED would welcome close collaboration with Projet Buffle as buffaloes are placed with farmers. SAED extension staff might well be able to assist with the extension of buffalo technology, and SAED would welcome a protocol outline areas of cooperation between SAED and Projet Buffle.

## Experiences of SAED, Projet FED

“Projet FED”, with technical cooperation and financial support from the European Community, operates within the framework of SAED in the district (“Département”) of Podor. It is levelling land for irrigated rice production. It considers animal traction to be particularly suited to the needs of the farmers with small areas of irrigated land, many of whom are organized within autonomous or semi-autonomous irrigation groups. Farmers have shown considerable interest in the use of draft animals, and project staff suggested that the only opposition seems to have come from those commercial sector interests (and some of their colleagues in influential positions) that wish to promote tractors, and who see animal traction as serious competition. The first 13 pairs of oxen were trained in 1987/88, this rose to 33 pairs in 1988/89 and 369 pairs in 1989/90. At the outset, mature animals already trained for work were bought from Kaolack, which was an expensive procedure but one that rapidly met the immediate needs. Project policy is now to buy younger, cheaper animals from nearby sources. The package, which includes animals, implements and an ox cart, is provided on 4-year credit, and with two crops a year, this represents repayment over eight seasons.

The project recommends the use of paired animals and a horn/head yoke, of the type found in the re-



gion of Kaolak. The project tried the SISMAR Houe Sine Greco and the SISMAR UCF plow. Farmers preferred the 10" UCF plow for plowing but used the Houe Sine for tine cultivation. Staff of SISMAR had visited the project to cooperate in the testing and evaluation programme, and as a result they had reinforced some components of the plow. SISMAR was apparently very interested to develop a plow well-adapted to irrigated rice production, and had indicated willingness to continue to cooperate in equipment evaluation and improvement.

Whereas four-wheel tractors could plow in dry conditions (indeed they cannot plow effectively in wet conditions), animals were unable to plow when the soil was hard. This was solved by a system of pre-irrigation whereby fields were flooded and left to dry out for about three days. They were then plowed with animals, with plowing rates of about 0.25 - 0.3 ha per day. After a few more days the fields were cultivated dry with tines (Houe Sine) as a harrowing/levelling operation. This was followed by flooding, hand seeding and subsequently hand weeding. Some farmers were starting to transplant rice rather than direct seeding.

Project staff were sceptical whether water buffaloes would thrive in the project area, where temperatures could reach 45°C at 25-32% humidity, and where there was little shade and few watering places.

The project was continuing to promote work oxen, and with this in mind intended to organize a demonstration at Diomandu, a newly developed irrigation scheme. The consultant and the acting project director went to the demonstration as arranged, but found it had been cancelled as it had been more difficult than expected to organize the pre-irrigation of the demonstration plot. This illustrated the point that in large-scale schemes, individuals or farmer groups that do not have their own pumps that draw on permanent sources of water are very dependant on the management of the scheme for pre-irrigation and for irrigation. Farmers in the Delta cited this a reason for abandoning animal traction, for without direct control over irrigation dates, they found it necessary to prepare when the soil was hard, and only tractors could plow. The cancellation of the demonstration through problems of lack of water for pre-irrigation also illustrated how vulnerable might be a farmer that owned a water-buffalo and relied on scheme-pumped water for its wallow.

Farmers contacted in the village of Foonolé As indicated they were pleased with their work oxen and

had experienced no major problems in their management and use during their first year of use. They indicated they used the pre-irrigation system described by Projet FED although for the first year they had used a tractor-drawn disk plow followed by animal-drawn tine tillage (Sine Houe). One farmer complained that his oxen did not work well after four hours (8 a.m. to 12 noon), and that it was an effort to make them work until 1 p.m. as they were tired. He was very pleased with his ox cart, which was in use at the time carrying mud for building construction. He intended to try ridging with the Houe Sine ridger for tomato production in the coming season. In that village there were 15 pairs of oxen and 15 ox carts. New ox carts, obtained through Projet FED were in evidence in several other villages, and at least ten were parked at the Dodel weekly market, with their oxen (all clearly branded with the initials "FED") waiting patiently.

### **Experiences of SAED, Projet Ile à Morphil**

Projet Ile à Morphil ("Projet Hollandaise") is supported by Dutch technical cooperation and operates within the overall framework of SAED. It is involved in developing the agricultural production of Ile à Morphil, notably through the establishment of irrigated fields for rice production. It is still in the process of levelling land and creating canals. It intends to work with farmer groups rather than individuals. It attempted to introduce tractor cultivation, but found this was fraught with problems of tractor operation and maintenance, and lack of personal responsibility for the tractors. It then tried to promote the use of draft oxen, but found the response was unenthusiastic. This was attributed primarily to the limited feed resources on the island and the near absence of cattle. There was also, according to project staff, a psychological barrier which made farmers reluctant to adopt the use of work oxen. Thus while the project has retained its demonstration oxen (which appeared to be large and healthy), it has recently concentrated on the potential for donkey traction. Large numbers of donkeys exist on the island, and many of these survive and breed with no human assistance. The project is currently both testing and promoting a novel system of hitching three donkeys to a plow, using collar harnesses and a system of eveners. Such a system has not been used elsewhere in Africa, but project staff are convinced it will prove suitable in the project area. Trials in 6 locations involving the cultivation of a total area of

about 2-3 ha of pre-irrigated land, have indicated that three donkeys can pull a plow through the soil of rice fields. Donkeys are known to be capable of tine tillage for upland crops. The animals themselves are considered to be virtually free of cost or management, and so no credit is required for animals. Each village group is being offered four multipurpose toolbars, on credit.

A further series of demonstrations of the technology is being arranged in several villages, using animals from within the villages. The consultant and the acting project director travelled to one such demonstration, but it was cancelled at the last moment due to lack of water for pre-irrigation. Following a series of shooting incidents across the river, the latest only two days before the planned demonstration, the villagers were scared to descend the river bank to their pumps, and thus could not provide the water needed to pre-irrigate the fields.

The project had obtained a large range of equipment for testing. It had the SISMAR range and had also received a consignment of multipurpose toolbars manufactured by Rumpstad in Holland. These had been designed in cooperation with projects in Mali, including the large Dutch-supported irrigation project "Projet Arpon". It had also received from Projet Arpon an animal-drawn conical puddler for rice fields. This had been made in Mali, from a design developed at the International Rice Research Institute (IRRI) in the Philippines. Other equipment for testing included a rotary harrow and some seeders. The project had not tested all the implements, but was anticipating that the Rumpstad toolbar would prove to be satisfactory. It had made a four-wheel trailer, but this had not proved satisfactory.

The project realised it was trying out several new technologies and that it was largely working alone. It therefore welcomed the possibility of collaboration with other projects in the testing and development of animal drawn implements.

Projet Buffle had had one extension slide show on the island, and as a result of this, one farmer had asked to purchase buffaloes. When asked why he did not accept the "Projet Hollandaise" donkey traction package, he pointed out that he was a reasonably large-scale farmer, and, as an individual, he was not entitled to the project credit package which was only for groups of small farmers. He had not obtained oxen, as no project had offered them. He now preferred a buffalo to oxen as he had been shown he only needed one buffalo, and he could obtain the

buffalo at a good price. He had no concerns about his ability to feed and manage the buffalo, nor about the ability of the buffalo to thrive in the hot and arid climate of the island (during the interview the temperature was about 43°C and it remained in the 40s from about midday to 9p.m.). He had his own water pump and so he would be able to make an artificial wallow for his buffaloes.

## Experiences of SAED, Projet Matam 3

The Matam 3 improvement project is administered by SAED with funding from Italy and the Kingdom of Abu Dhabi. It is developing a large area of irrigation about 50 km from Matam, which itself is about 350 km by road from Saint Louis. The irrigation scheme visited was in its second year of operation, but was still under development. The scheme will initially allow only one crop a year. Soils are reported to have a higher sand content than those used for rice production in the Delta, and tine-cultivation was found adequate in the initial year. Project staff feel a mouldboard plow may be needed when cultivating soils with root systems of the previous year's rice crop.

Donkeys and horses are already widely used for transport work, and a high percentage of farm compounds own one or more cart. Some horses and donkeys are employed for the cultivation of upland crops using the SISMAR range of implements, notably the Houe Sine and the Houe Occidentale cultivators. There had been some earlier schemes to introduce the use of work oxen, but these seem to have left little impact. Feeding of work oxen throughout the year was apparently considered to be a problem, particularly during the severe droughts of the early 1980s.

Matam 3 has recently started to promote the use of work oxen for rice cultivation and transport, and has provided 4-year credit for oxen, SISMAR cart and Houe Sine, selection and purchase of animals and village-level training by project staff. Even farmers who owned cattle were entitled to have oxen bought for them, and trained at a temporary training centre established in a village. Three farmers who had recently received credit and had taken part in the training scheme were contacted in Hamady Ounaré village. They had been allocated 0.8ha, 0.8ha and 2.4ha (3 x 0.8ha) of irrigated land respectively. All had used horses or donkeys for transport, and in some cases for upland cultivation, but all considered

ox traction to be a new technology. One farmer owning cattle, horses and donkeys considered that when it came to using oxen, he was a pupil learning from, and dependant on the project, and that if he had a problem, he would go first to the project. Given a choice, he would have preferred a second donkey cart or horse cart to an ox cart, as this could be used for income-earning transport of people. However he had not had a choice, and he thought he would use his cart for carrying farm produce. Another farmer in the same village considered that while he had needed project initiatives to get him to train and use work oxen, he could now continue the technology, independently from the project if necessary. He considered his ox cart would be used more like a lorry, and his horse cart more like a car or taxi. It was too early in the scheme for farmers to make many comments or suggestions relating to animal traction implements or constraints. One farmer suggested he preferred the Houe Sine to his old Arara-type plow as it had a wider working width (i.e. he found tine cultivation faster than mouldboard plowing).

Following promotion visits by staff of Projet Buffle, two farmers wish to purchase water buffaloes. The consultant and the acting project director visited the farm of one of these. The 5 ha site was at the edge of permanent water course of the river, and the farmer had his own pump. He was clearly an innovative farmer, who was developing an intensive mixed farm which he intended to run himself, with family labour. The main area was to be rice, but he had also planted vegetables and several varieties of fruit trees. He was in the process of constructing fish ponds, and intended to make a buffalo wallow by these. Until recently, he had used a two wheeled tractor (power tiller) obtained through a project, but spare parts were unavailable, and he had no means of replacing it. He had heard about the advantages of buffaloes through a project slide show. He had always been an innovative farmer, the first in the area to use fertilizers, improved varieties and a power tiller, and he wanted to be the first to use water buffalo. He foresaw no management problems, although it might be difficult to obtain feed at first as his present stock of straw was minimal. With his own pump, he could pump water to a drinking trough (which he would make) and to the wallow. He would construct a shade by the river bank. During the interview, the shade temperature was 44°C and reflected heat from the sandy soil was intense. Later in the day, as the reflected heat decreased, the hot,

dry wind increased, and maintained the air temperature in the 40s until late in the evening.

## Nearby experiences with animal traction

Animal traction is used to a limited extent for rice cultivation in Casamance, Guinea Bissau, Guinea and Sierra Leone. N'Dama cattle (c. 180 kg) are used in pairs with head yokes. The cattle are tolerant of trypanosomiasis and streptothricosis. A single-purpose mouldboard plow between 6" and 9" is generally used. Animals are used to plow rainfed rice and swamp rice. Despite attempts introducing the "Asian" model of water control, most swamp rice is grown in "undeveloped" swamps, for very rational reasons (Leaman, 1988). Animals are not used in the very heavy soils of the mangrove swamps of Guinea Bissau and Sierra Leone. For these soils there is a notable shortage of power and (in this respect only) there may exist a potential comparative advantage of large water buffalo over small N'Dama cattle.

In The Gambia, rice is traditionally a women's crop, and women seldom have access to animals (Jones, 1990). The Jahally Perchad irrigation scheme made rice production very profitable, and men were quick to accept that rice production could be for men as well. Various farmers in the scheme use tractor, animal and human power for tillage. Animal power generally involves N'Dama or Zebu oxen (or cross-breeds) although horses and donkeys have been observed pulling plows.

In Mali, Projet ARPON is a huge, Dutch-supported irrigation project on the edge of the Niger river. In 1986 40,000 ha of irrigated rice were cultivated by 25,000 pairs of oxen, and the project was due to expand still further. The project had its own workshop making harrows (not very popular) and plows, based on designs from Rumptstad in Holland. It also tested various types of rice-production equipment including a conical puddler, and example of which is with SAED's "Projet Hollandaise".

There appears to be little use of draft animals for rice cultivation in Mauritania. Some plows left over from "Opération Charrue" of the 1960s are apparently still used with work oxen.

These examples suggest that there have been many activities relating to the use of draft animals for rice production in Senegal and neighbouring countries. Much scope exists for learning from other people's



experiences and benefiting from the various successes and failures in this field.

## Equipment availability

The SISMAR range of animal traction implements is widely available within Senegal. New equipment is available from the SISMAR factory at Pout and from a number of development projects. Second-hand equipment is commonly found in markets in areas where animal traction is widely used. Copies of implements made by local blacksmiths are not unusual.

The SISMAR range includes the UCF plow, the Houe Occidental, the Houe Sine, the Ariana and the Polyculteur. The latter two are rarely used. The Houe Occidental is low and light and is the main implement used with donkeys. The Houe Sine is the implement most commonly used in the groundnut basin, and in The Gambia, and similar models are widespread in neighbouring Mali. It is mainly used as a tine cultivator, earthing-up ridger and groundnut lifter, although it can be used as a plow. The heavier Arara toolbar is seen in Senegal, but is not common. It is employed elsewhere in West Africa, notably Benin and in Niger (Ashburner and Yabilan, 1990). The SISMAR UCF plow is used those areas of Senegal with higher rainfall such as Casamance where plowing, as opposed to tine tillage, is practised. In Casamance there is also some use of the Emcot ridging plow, obtained from The Gambia.

During the present visit, the consultant talked to farmers who happened to be selling and buying animal traction implements at Thilène, about 25 km from Makhana. The equipment comprised three SISMAR Houe Occidental cultivators, a copy of the Houe Occidental made by a local blacksmith at Ross-Bethio (35 km from Makhana), and an imported toolbar ("multiculteur") apparently originally supplied by a development project. The Houe Occidental cultivators looked as if they had been widely used and repaired. They had been employed for the cultivation of upland crops (groundnuts, maize, millet and sorghum).

In the Fleuve, Projet Ile à Morphil (Projet Hollandaise) has a stock of 100 toolbars made by Rumpstad in Holland. These are apparently of a design used in a large-scale irrigation project in Mali. The project also has other implement design samples, including a rotary harrow, a puddler, harrows and some plows.

Elsewhere in the country, prototypes and sample implements can be found at the SISMAR Pout factory, in several ISRA research stations (notably Bambey), and at the headquarters or field sites of several agricultural projects run by government agencies and non-governmental organizations.

## Equipment suitability

Plowing with draft animals is impracticable in hard, dry soils where irrigated rice is grown. For this reason plowing is performed either in wet soils or in pre-irrigated soils (pre-irrigation involves flooding fields, then leaving them for a few days to dry out a little). The pre-irrigation system is preferred, as both buffaloes and humans find it easier to work in soils that are soft and moist, rather than those that are immersed in water.

Staff of Projet Buffle have found that both the SISMAR UCF plow and the SISMAR Houe Sine plow perform acceptably well in soils that have been pre-irrigated. Project staff have therefore tentatively decided on issuing Houe Sine toolbars with plow attachments to farmers buying buffaloes. The consultant fully endorses this decision. The UCF plow may be slightly better as a single-purpose plow, but the Houe Sine is a competent and well-proven design. In flooded soils both plows can work (and they have been used elsewhere in flooded conditions) but the draft is high, and single animals may work better with the 6" or 8" versions, rather than the large 10" plow. The Houe Sine has already been used successfully for plowing swamps in northern Senegal (in the areas of Projet FED and Projet Matam 3). It has also been used for swamp rice cultivation in Casamance, The Gambia and Sierra Leone. Moreover, with the Houe Sine, the farmers can use the cultivation tines for tine-tillage or harrowing, and the ridger for vegetable crops such as tomatoes.

The consultant accepts that the Houe Sine was designed for rainfed farming in the sandy soils of the groundnut basin. Thus it may not be the ideal implement but it is competent and readily available immediately. It is extremely unlikely to be a limiting factor to the success of Projet Buffle. There are many examples of basic plows being used successfully for rice production in Senegal and elsewhere in Africa. In contrast there are few, or no, examples of Asian-type rice production implements being used in Africa. It is to be remembered that in Asian production systems, the same implements are used by cattle and buffaloes in rice swamps, and so the fact that this is

a buffalo project should not prevent it from learning lessons from other rice production schemes in Africa.

In due course equipment designed specifically for the needs of rice production in northern Senegal may be developed. These might even be based on Asian designs, although as noted, such designs do not seem to have been transferred successfully to date. For the present time, *Projet Buffle* has no expertise in this field, and it is unrealistic to expect equipment to be developed during brief visits by consultants unfamiliar with local farming systems. Recent discussions between SISMAR and *Projet FED* concerning possible collaboration seem encouraging, as does the importation by *Projet Hollandaise* of equipment used for irrigated rice production in neighbouring Mali. The staff of *Projet Buffle* are recommended to keep in close contact with these projects, and other organizations testing and developing implements for rice production. However they should not let this distract from their main task of following the progress of the farmers using water buffaloes.

The project has tested a few other plows, but these have not found favour. The wooden Thai plow, effectively a symmetrical wooden ard with a steel tip, tilled the soil, but being symmetrical did not invert the soil. It broke, and has not been used, but has been retained as a model. This was "copied" in steel by a workshop in Saint Louis. The copy was not a replica and had a most odd shape for the "mould-board" (the workshop obviously had no idea of the role of the different parts). It can be used to till the soil in flooded swamps. Being narrow, it had an acceptable draft (although quite high) but depth control proved difficult for people unfamiliar with such a design. A prototype "Makhana" plow was built based on the sketch (without dimensions) of Jacob and Roosenberg (1987). This proved inferior to the Thai design, and during a demonstration the prototype, with a fairly wide mouldboard, had no scouring action and so exhibited all the finesse of bulldozer. There is no doubt that such a prototype could be improved on, adjusted, fine-tuned and modified: it could go through numerous cycles of alteration and testing. However even if the project made a large effort to work on this design, there is no evidence that suggests this would lead to its adoption. There are many well-proven designs of swamp plow which could be tested in preference to this unproven prototype should farmers consider that equipment suitability be a crucial limiting factor.

A prototype Japanese plow, developed by SISMAR, has been lent to the project for testing. The traditional Japanese swamp plow design is intrinsically simple, with narrow, symmetrical plow body without landside and with a narrow "bottomside" giving low draft and some stability. The SISMAR model is more complicated, being designed by engineers to be easily adjusted. Personal communication with the person responsible for revising the famous FAO book on animal-drawn implements (Hopfen, 1969) confirmed that the Japanese plow had been found superior in various trials, but also confirmed that its uptake had been slight. For example 200 implements were made in Bangladesh, but the design did not spread, even among those working entirely in rice swamps (Constantinesco, personal communication, 1990).

Harrowing and puddling do not seem to feature largely in the irrigation schemes of the Fleuve. This may be because most rice is hand seeded rather than transplanted. Clods left from plowing may be broken with the tines of the *Houe Sine*, as some farmers reported. Others indicated that the weather and the flooding levelled the field. If these operations are not perceived to represent a constraint, there may be no need for the project to become involved. However, this may be one operation for which buffaloes have a comparative advantage over oxen, and trials with harrows, levellers and puddlers may be desirable, if a distinct need is perceived (at present this does not seem to be the case). During the present visit, the consultant was unable to observe the operations between plowing and seeding, to see what needs were apparent for harrowing, levelling and puddling. High levels of weed infestation were apparent during field visits. This might have been due to inadequate water management, but it is possible that the situation could have been improved with greater efforts in puddling and levelling. In this respect it would be worthwhile to visit the Jahally Perchad irrigation scheme in The Gambia, only a few hours drive away. This reputedly has some of the highest rice yields in the world and their techniques and equipment used for primary and secondary cultivation should be of great interest to the project. If no special equipment for secondary tillage is used in this scheme, this will provide reassurance to the project that the present neglect of this operation appears to be rational. On the advice of USAID, the consultant did not travel to The Gambia during this current visit and so he recommends that a member of the project staff do so in the near future (a visit

with someone from Projet FED and/or ISRA might be very appropriate). Information from Projet Arpon in Mali, would also be of great interest.

The comb harrow is widely used in some parts of southeast Asia, but not in Africa. It has been tested in Sierra Leone, and has been found effective (Starkey, 1981) but has not been promoted or adopted. Of the two designs available at Makhana, the simpler one is more widespread in Asia, as it is more easily portable and manoeuvrable. Apparently project staff preferred the stability of the larger, heavier design, which is also of Asian origin. A triangular spike-tooth harrow and leveller has been tested in Sierra Leone, and adopted to a limited extent (Starkey, 1981). While this could be fabricated easily in northern Senegal, it should only be tested if a distinct need is observed, for which there is no existing solution. The conical puddler developed by IRRI that is available at Projet Hollandaise might well be tested with buffaloes, although this would have to perform a vital function (such as improved weed control or increased yield) to justify its high cost.

The project has supervised the fabrication of an earth-moving scoop, based on a design from the International Livestock Centre for Africa. This works well, but is quite expensive. In Egypt similar scoops made of wood are used to level rice fields, but it is not recommended that wooden scoops be developed for Senegal. The scoop could prove useful in developing level rice fields, and it is suggested that it be shown to other projects in the area (Projet FED, Projet Hollandaise, Projet Matam 3). However unless it were used to make buffalo wallows (which it might) it is not an implement specifically designed for buffaloes. Thus while the project might well try and see how the scoop might help farmer groups in rice-producing areas, this should not be a priority for the project. As mentioned, the project should concentrate its own manpower on the buffaloes, and encourage other organizations to take up work relating to animal traction in general.

ISRA has been cooperating with the French organization CEEMAT in the testing of implements for use in dry soils. One of these implements, the Roliculteur, with two gangs of rotating blades is quite an expensive implement to produce, but may prove valuable for the rapid cultivation of sandy soils (Le Thiec and Bordet, 1990). It has been lent by ISRA to Projet Buffle for possible use in rice production systems. Initial tests indicate that while it is useful for loosening the sandy soils of the Makhana dunes,

it may not be suited to the heavier soils used for rice production. This is not surprising for the implement was not designed for rice production. Nevertheless such rapid tests with already existing implements are to be welcomed, for they involve little time compared with prototype development, and might possibly lead to new insights in relation to equipment options.

It must be stressed that wherever practicable, all such tests and trials relating to cultivation implements for rice productions should be carried out in cooperation with other organizations, such as Projet Fed and ISRA, that have far more experience and resources than Projet Buffle.

## Equipment demand

The demand for equipment from buffalo farmers in the coming decade will be low. Perhaps ten sets of equipment per year. This is negligible in comparison with the demand from oxen-using farmers in the region (Projet FED has placed over 300 sets of implements in the past year). Even the most wildly optimistic estimates do not suggest there will be demand for more than a small number of implements a year in the coming twenty years. This further supports the decision of the project to make use of existing equipment designs, for which a market already exists. Nevertheless, should the project identify an implement that would improve animal powered rice production using buffaloes, then it would almost certainly also be suitable for use with oxen. This would give such an implement a wide potential market in the oxen-using rice production schemes in Senegal, The Gambia, Mali and elsewhere.

## Local maintenance capabilities

The maintenance of the standard ranges of animal traction equipment is not considered to be a limiting factor. Village and urban blacksmiths in the Delta and Senegal River area seem quite competent at repairing the SISMAR range of cultivators, plows, seeders, carts. etc. Several blacksmiths were visited and provided evidence of their work skills. Equipment was seen in villages that had been repaired, and farmers expressed satisfaction with the repair services. Repair facilities do not necessarily exist in all small villages, but farmers would not have to travel further than the local weekly market to obtain artisanal repair services. Scrap metal supplies seem adequate. While there may well be scope for improving the efficiency of the artisanal sector, it is

considered adequate for the needs of maintaining “standard” types of steel animal traction equipment.

Local artisans are not familiar with wooden animal traction implements. Carpentry skills exist for the creation of yokes for oxen, and carpenters can generally copy items. Wood of all types is in short supply in the north of the country, and consequently is relatively expensive. The introduction of wooden animal traction implements requiring significant carpentry skills for their repair and maintenance would almost certainly lead to problems in the short term. In the longer-term the local artisans might well respond appropriately to the repair and maintenance needs and might be able to obtain suitable timber, provided there was sufficient economic incentive. Such incentive might come from an economic demand from a critical mass of small farmers, or from a few wealthy farmers or projects. However this is in the realms of conjecture, for unlike the proven situation with steel animal traction implements, there is little evidence to be sure whether or not present artisans have the skills to maintain wooden implements.

Harnesses for horses and donkeys are widely available. Most are made from old tyres and synthetic materials, but there is some use of leather. There seems to be a large disparity among the harnesses in use, which range from well-maintained, neat systems, to those comprising mainly joins and patches. The comfort of the animal does not seem to be of major concern to those responsible for fitting and maintaining harnesses, particularly in the case of donkey harnesses. Leather working skills exist in the region, but in only a few places are harness makers used to working with leather. Given the skills that exist in the region, the repair and maintenance of harnesses for draft animals should not be a limiting factor for farmers wishing to use harnesses effectively. This does not necessarily imply that harnesses will be well maintained or correctly used.

### **Local production capabilities**

The SIF workshop where the prototype buffalo plows were made is clearly capable of copying implements and following detailed instructions. It has no knowledge of farming systems nor the use to which implements will be put. Thus while it can accept contract work, it has no “common-sense” in relation to agricultural implements (for example, it has no idea of what might be appropriate as a mould-board shape and it did not occur to the workshop

staff that it might be inappropriate to use small hexagonal nuts and bolts for adjustments to a part of the plow that would be regularly immersed in mud). Although based in the Delta region, the workshop has no direct contact with farmers and therefore no potential for feedback with farmers. Most of its work seems to be construction of fencing, security bars, windows and contract construction and repairs, and all these provide regular sales and income throughout the year. It therefore would have little interest in making agricultural implements for direct sale to farmers, an uncertain and highly seasonal market. Naturally it would be prepared to make agricultural implements on contract for projects, but such one-off contracts would provide little or no scope for farmer feedback.

The SISMAR factory at Pout is perhaps the largest producer of animal traction implements in Africa. It has thousands of its products in use in Senegal and it exports to several countries, including The Gambia and Guinea Bissau. It was formed after its predecessor, SISCOMA, went bankrupt due to the drastic reduction in sale of animal traction implements that followed the ending of the national agricultural credit programme in 1980. SISMAR knows that its survival depends on product diversification and sustained sales of its animal traction implements. It has a very strong vested interest in the development and production of implements suitable for swamp rice production, with potential markets in northern Senegal, Casamance, The Gambia, Guinea Bissau and elsewhere in West Africa. It has already cooperated with projects in Casamance to produce prototype implements, and has offered to cooperate closely with Projet FED at Podor and Projet Buffle in the development of animal-drawn implements for rice production. SISMAR has staff able to develop prototypes and pre-production models, but to date it has come up with few successful innovations. Most of its products were developed in the 1950s and 1960s by agricultural engineers such as Jean Nolle. SISMAR seems to have two weak points, both related to its large size: it has weak quality control and limited capacity to assess and respond to farmer feedback. It is because of this latter problem that it is willing to work closely with animal traction programmes in the region, and in this respect it represents a major resource for projects wishing to develop alternative animal-drawn implements.



## Animal training

The training of buffaloes at the Makhana farm appears well-organized and looks impressive. The innovative use of the “running W” ropes to assist training appears to have been successful. Unfortunately, during the present visit, this superficial impression was shown to be somewhat unreliable. During an on-farm demonstration of the use of buffaloes the animals totally failed to perform satisfactorily. This was particularly disappointing as it was possibly an historic occasion: it might have been the first time that farmer-owned swamp buffaloes had undertaken an on-farm plowing demonstration in sub-Saharan Africa. The buffaloes refused to work, and when they did walk, they chose their own paths, and their controllers followed them (irrespective of the previous furrow position). What is more, no one seemed to have any idea of how to use a mouldboard plow, they did not seem to appreciate the basic idea of plowing in rectangles. A similar poor showing occurred when project staff tried to use a mature animal at Makhana to demonstrate the different plows available. The animal either refused to work, or chose its own route.

Of course excuses can be made. The animals on the farm had been there for a month, but had not been worked. They were quite young animals (2.5 years). The farm supervisor was not the owner, and he had no obvious vested interest in having well-trained animals, since he had access to tractors for land preparation. The animals at Makhana were not being worked regularly and so were out of training.

Nevertheless the demonstrations highlighted a major problem with training. When animals are trained, they seldom follow furrows, and the trainers are content to follow the animals. If a plow is hitched, it is simply pulled around scratching well-loosened soil, and the animal is not expected to follow the previous “furrow” which does not really exist. There is no question that the senior and junior staff have the capabilities of training their animals well. It appears that the unfortunate demonstrations were the result of the animals not being trained for useful work. Clearly this is unsatisfactory, and the project will have to make a big effort to ensure animals are not simply trained to walk round a training field, but are trained to effectively plow rice fields. If buffaloes are not trained to follow furrows, then the project will have to make use of one of the symmetrical plow designs, which are more appropriate for “ran-

dom” tillage across fields.

## Some attitudes to Projet Buffle

The Directeur de l'Elevage, whose ministry has overall responsibility for the project, considered the project a useful, pilot initiative that would assess the potential use to Senegal of a valuable species.

Staff of other development projects seem to regard Projet Buffle with a mixture of incredulity and fascination, with a trace of derision. The project has maintained a low profile, and has only recently erected signs on the road indicating its location. Thus several people working with animal traction in the project area had little idea of the aims and objectives of the project. They were generally doubtful as to the potential role of buffaloes in the local farming systems. Those who had participated at the workshop held in October 1989 had much more of an idea of the role of the project and the positive attributes of buffaloes, and took the project more seriously. Staff of the Canadian non-governmental organization CECI that has been working with farmers close to Makhana for several years appeared fully convinced of the value and appropriateness of water buffaloes, and will help farmers to obtain a pair.

Those farmers contacted who had decided to purchase buffaloes had already been exposed to the publicity of the project. They were well aware of the advantages of buffaloes, and were all extremely confident that the buffaloes would thrive in their hands. They were all aware of the need for buffalo wallows, and had intentions of making them, but not prior to the arrival of the buffaloes. They knew that stocks of feed would be required, and considered that this would be no problem in the long-term, when they had their own residues. They indicated that they would make unspecified arrangements for feed supplies in the short term.

The farmers had chosen buffaloes for various reasons. They were cheap. The price of 50,000-70,000 F CFA was less than half the cost of an ox (or to put it in a different perspective, the cost was about the same as a good, but not exceptional, Tabasci ram). Farmers had been shown that one buffalo could do the work of two oxen. They were specialized for work in rice fields. Most farmers did not have access to alternative animal traction packages. One farmer who may have been able to obtain an ox-based package wanted to be seen as the innovator in his area and other farmers were already using oxen.

Oxen-using farmers contacted had not heard of the buffalo project, and so they could not comment on the relative advantages or disadvantages of buffa-

loes. They had chosen oxen because a credit package was available to allow them to purchase the oxen, equipment and a cart.

# Discussion of issues raised

## Needs of farmers

For rice production, farmers dependent on communally administered irrigation systems require relatively rapid tillage once or twice a year. Those with their own water pumps can be more flexible. In the Delta it seems that their needs are presently being met by tractor power. Tractors are less available in the Fleuve, and farmers in many areas require an appropriate source of power, such as that provided by animals.

According to discussions with farmers and projects, the apparent needs of farmers for rice cultivation can be met with pairs of work oxen, using SISMAR implements. This is dependent on pre-irrigation, requiring either communal cooperation or personal access to water and pumps. In the Isle à Morphil, it is suggested that limited numbers of cattle, limited feed resources and local prejudices may make donkeys more acceptable than oxen, although this has yet to be proved.

Farmers also require transport, but horses and donkeys are the preferred transport animals. Oxen owned for cultivation can also be used for transport, which justifies their keep further.

Farmers require animals that optimise their farming systems, possibly by minimising their risks and maximising their profits for an acceptable work load. They require animals that are affordable and readily available and so easily traded-in in case of problems. They require animals that can survive in the climate with minimal attention, with minimal additional feed. This suggests the donkey would be an ideal animal, but farmers also require the power to perform tillage, and systems of using donkeys for the cultivation of rice fields have yet to be proven. Oxen appear to combine reasonable affordability, availability and adaptability with power sufficient for the tasks. Due to various project training, extension and credit schemes, oxen are increasing quite rapidly in the Fleuve. Apart from the problems cited in the Isle à Morphil, there do not seem to be many constraints to the effective use of work oxen.

Farmers wishing to try buffaloes did so because they were cheaper than oxen and because they had been convinced that buffaloes were better at swamp plow-

ing than oxen and that one buffalo could do the same work as two oxen. The animals carried a certain status in relating to their novelty and their association with an aid project.

Farmers are aware of the problems of feeding animals during the year, and they may have been attracted to the buffalo because it was reputed to like rice straw, and it was assumed that one buffalo would require less feed than two oxen. Farmers do not seem to have requested buffaloes due to the inability of oxen to plow heavy soils, for there has been no suggestion that the single buffalo would be significantly stronger than two oxen.

## Introduction of multiple technologies

The project has been trying to develop a completely new package based on many innovative technologies. The animal itself is highly innovative, and has yet to be used as a work animal in the villages of sub-Saharan Africa. It would seem to be a major challenge simply to assess the performance and survival of buffaloes using technologies already well proven in Africa. However the project has also tried to develop new implements and harnessing systems. It is currently using a harnessing system that has not been proven by farmer adoption anywhere in the tropics. The phase one also referred to inter-species crossbreeding trials, although these were not undertaken (this would have been very difficult and prospects would have been slight as earlier mating trials in Tanzania and South Africa had never resulted in offspring [Cockrill, 1974]). The phase 2 referred to establishment and evaluation of different pasture grasses and the development of ensilage techniques. However there are few, if any, records of animal traction farmers in sub-Saharan Africa planting single-purpose fodder crops or making silage.

Thus the small project team has been trying to solve a whole series of major problems at the same time. While this may illustrate laudable courage, it may also reflect insufficient appreciation of the project's own limitations and also an inadequate review of previous efforts in these fields. Of course, if by skill or chance the project came up with a perfect package of new technologies, this would represent an



amazing success. If, as is much more likely, the package has problems, it will be difficult to draw adequate conclusions as all the technologies will have been confounded (in a statistical sense). If the new animal-traction technology, with a novel species, a new harnessing system, a new prototype implement and a new system of feeding is rejected, does it necessarily mean that buffaloes are inappropriate? If it does not, then further years of work would be indicated to "perfect" the whole package, with no assurance of ultimate success.

It would seem that the project should try to reduce the number of variables, using as far as possible technologies which themselves have been proven appropriate in the region. In terms of harnessing, this would suggest the double withers yoke, used with buffaloes in many countries in Asia and also used with cattle in many African countries. The single withers yoke, used in some countries in southeast Asia, might also be evaluated, with the understanding that this is a more innovative technology to be treated with appropriate caution. In terms of implements, in the first instance packages that have been found appropriate in irrigated rice schemes in the Fleuve itself, in The Gambia or in nearby countries (notably Mali) should be evaluated, with preference for those that are readily available. This would suggest that the SISMAR UCF plow and the Houe Sine toolbar should be tested first. If the animals prove well-adapted, but the implements are judged by farmers and project staff to be inadequate to maximise the advantages of buffaloes, then there would be justification for modifying designs or for looking further afield for alternative designs. Naturally, such work would be carried out in close cooperation with other interested organizations (such as Projet FED, Projet Hollandaise, SISMAR and ISRA). Projet Buffle itself has no comparative advantages in implement design, and should only resort to the time-consuming process of prototype development if it can find no other way of responding to specific needs of farmers.

## **Comparative advantages of water buffaloes in Senegal**

The project document talked only of the comparative advantages (assumed) of water buffaloes over tractors and hand cultivation. Certainly buffaloes are unlikely to be adopted for work if tractors or hand operations are technically and economically superior in the local farming systems. However the most impor-

tant comparison is likely to be between buffaloes and other work animals, for the technical and economic conditions that favour buffalo traction, may well also favour the use of working cattle, horses or donkeys. The buffalo has two major advantages over other working animals in the area, and several disadvantages, and the project should naturally endeavour to maximise the advantages.

The first advantage is that individuals are heavy and are strong. This advantage has not been maximised by the project, since it has chosen to work with single animals. One adult buffalo weighs a similar amount as two local oxen, and has a draft capacity similar to a pair of oxen. Thus for a given power requirement, what is the advantage of a buffalo over a pair of oxen? In real economic terms, a given biomass of buffalo is unlikely to be cheaper than that of cattle, so a pair of oxen would be unlikely to cost more than a single buffalo. With two animals one has less risk (a single accident or mortality will be less serious). While the two oxen may require more feed than a single buffalo, they may well be able to work on lower cost feed. A single buffalo carrying out the same work as a pair of oxen, is more likely to require concentrate feed to meet its energy requirements.

Water buffaloes, with their large hooves and pattern of walking are well adapted to walk in deep mud. Oxen can, and do, work in deep mud, but buffaloes are superior at this. In present farming systems in the Delta and Fleuve there is no real need to walk in deep mud. In the Delta, dry tractor tillage followed by flooding and seeding is the norm, while further up the Fleuve a system of pre-irrigation has been developed to allow animals to work in moist, but not flooded, conditions. Thus in existing farming systems, buffaloes are unable to make use of this comparative advantage. While it is possible that profitable farming systems might be developed based on tillage in flooded conditions, such systems do not appear to exist at present. It would take significant resources, far greater than those available to Projet Buffle, to carry out trials on alternative systems of cultivation that might favour the water buffalo.

On the negative side, buffaloes tend to walk more slowly than oxen and usually have a slower reproductive rate. Reproduction at village level is often low, due partly to the difficulty in detecting oestrus. More importantly water buffaloes are sensitive to two important diseases: trypanosomiasis and streptothricosis. These do not appear to be a problem in the

Fleuve, but they do exist in Casamance, and so may limit the potential for buffalo in southern Senegal.

In the Fleuve region, the biggest problem with buffaloes is likely to be their poor ability to regulate their temperature when faced with hard work and climatic stress. Having only 10-20% of the number of sweat glands that cattle have, they rely on wallowing in pools of water to keep cool or to recover from temperature stress. Pearson (1990) reported that pairs of buffaloes in Nepal pulling a light load (350 Newton) in air temperatures of 24-37°C, suffered thermoregulatory stress with raised body temperatures, panting and eventual refusal to work. Work oxen performing identical work did not suffer in this way, and did not need to stop to wallow. During continuous light work, the body temperatures of buffaloes rose by up to 3.5°C, and did not decrease rapidly unless the animals were able to wallow in water for 15-20 minutes. Simply resting or being splashed with water did not have much effect in bringing their temperatures down (Pearson, 1990). Similar findings have been reported by other researchers. In the higher reaches of the Fleuve, at Podor, Cascas and Matam, ambient temperatures may be over 40°C for eight hours a day, and this is combined with limited natural shade, high heat reflection from sandy soils and hot, dry winds. These conditions themselves, even without work, may cause water buffaloes major stress unless they have access to deep shade or are allowed to wallow. Natural wallows do not exist in the dry season, and so artificial wallows must be produced by pumping water, and this has implications for attentive management and costs of maintaining buffaloes.

In the foreseeable future, oxen will have advantages over buffalo in terms of price, availability and adaptation to the local environment. These are important considerations for farmers concerned with risk. If an ox were to be injured, it would be relatively easy to sell the animal to a butcher and purchase a replacement rapidly from one of the many herds in the region. Alternatively, as Lhoste (1990) argues, farmers can maximise profits from weight gains by trading in work animals every two to three years. With buffaloes, availability will be a major problem in the foreseeable future.

## **Comparative advantages of Projet Buffle**

Projet Buffle has a small, but highly motivated team of senior staff and junior trainers. The senior staff

are veterinarians and animal scientists, not agricultural engineers. They have little experience in research. Their advantages lie in continuing to ensure buffaloes are maintained in good health and in good conditions of management, and in their enthusiasm which has led to significant farmer and project interest in the potential for buffaloes. Since the project does not have a comparative advantage in implementation testing nor does it have experience of undertaking rigorous research, it should cooperate with other organizations better able to undertake these functions.

## **Comparative advantages of implement designs**

SISMAR implements have the advantages of being readily available, affordable and can be maintained in the villages. Their performance has been judged by farmers to be acceptable. These implements offer great advantages to the project in that they do not have to worry about implement testing and research.

Other implement designs may, or may not offer better performance, and may, or may not, become available, affordable and maintainable. In the long-term they may prove to have a comparative advantage, but in the short term their uncertainty puts them at a comparative disadvantage.

## **Comparative advantages of implement producers**

SISMAR is a local factory, with a vested interest in developing its market for agricultural implements. It has proved capable of producing implements of acceptable price and quality. It lacks close relations with farmers.

Local workshops, such as SIF, are close to Makhana but offer no other comparative advantages. They have no experience of agricultural implements and have not obvious vested interest in developing agricultural implements, except as project-financed contracts. It also has limited relations with farmers.

Local artisans are close to farmers. They do not have the equipment or experience to make high-quality animal-drawn implements, but can make acceptable implement in small numbers. If their designs are successful they have difficulty in producing to an increasing demand. They have a comparative advantage in repairing and fine-tuning existing equipment for local farmers.

## Comparative advantages of USAID

USAID has an international perspective, contacts in most countries in the world, and access to international publications. It has an absolute comparative advantage over *Projet Buffle* and GOS in its ability to obtain information on the use of buffaloes in Africa and elsewhere. To date USAID has not used this comparative advantage for the benefit of *Projet Buffle*.

## Projection of water buffalo population

The reproductive rate of the water buffaloes at Makhana has been good. However there have been few, if any, serious attempts to project the number of water buffaloes in Senegal, assuming the project goes into a third or fourth phase. The 1987 evaluation put a tentative figure of 76 animals in 1997 (assuming a third phase). The assumptions which formed the basis of this figure (including 28 cows and 48 calves) were not made clear. There are no data available on reproductive rates and calf survival at village level in sub-Saharan Africa. In southeast Asia, in areas where buffaloes have been kept for generations, village level reproductive rates are generally low. This is due to a variety of factors including limited contact between bulls and cows (as few farmers own both) and difficulty in detecting heat to bring cows for service. This is likely to be the case in Senegal, where initially buffaloes will be widely dispersed, with few farmers owning both male and female animals. High calf mortality has been the source of low population growth rates in several parts of southeast Asia, but again no data exist for Africa. It is unlikely that further importation could be justified to increase the population significantly, and importation to increase genetic diversity would be most economical if it were based on semen importation. In the short term, both the genetic diversity and the potential for reproduction at village level will be severely constrained by the lack of breeding bulls. Only three entire bulls of the original six that were imported remain (the other three were castrated for reasons more concerned with short-term on-station management than long-term reproductive needs). Furthermore only 7 male calves have been born, of which one was castrated (reportedly in order to stimulate growth). With few bulls available for village reproduction, any growth in the buffalo population is likely to be as a result of reproduction of the nucleus herd at Makhana. This herd is already

stretching the management and feed resources of Makhana, and so the breeding herd is unlikely to increase significantly unless a major expansion is envisaged in a phase 3.

The implication is that there are unlikely to be more than 100 water buffaloes in Senegal by the year 2000. To put this figure in perspective, *Projet FED* has recently placed about 600 draft oxen for use in irrigated rice-farming systems in Podor, and anticipates its programme to continue to develop rapidly. *Projet Matam 3* is also assisting farmers to use work oxen for rice production, and envisages several hundred in use. Other projects in the region (such as "*Projet Hollandaise*") are also intending to promote animal traction for rice production, using donkeys or oxen. Thus however successful the water buffalo are, in the coming decade, their numbers will continue to be very small in comparison with other draft animals in northern Senegal. Even if highly favourable assumptions are made about reproductive rates, survival and farmer preferences, a similar situation is likely to exist for at least another generation. This has important implications in terms of market demand for animal-drawn implements for rice production and support services in the Senegal river basin. Elsewhere in Senegal, disease constraints are likely to mitigate against the success of water buffaloes in Casamance, but even if water buffaloes could survive in villages there, it would be over a human generation before numbers would be significant. Thus in the south N'Dama cattle are likely to be the dominant draft animals for rice production in the foreseeable future.

## Temperature regulation and heat stress

There has been no suggestion that project personnel have been concerned with the problem of heat stress in buffaloes. However the consultant noticed that animals undergoing training were showing signs of heat stress after only one hour of light training work. The symptoms included panting, frothing at the mouth and apparent dejection. On taking rectal temperatures it was apparent that light work in the cool (30°C) conditions of Makhana was causing body temperatures of the animals to rise by between 2°C and 3.5°C. For example on the afternoon of 11 June 1990, buffalo 27, undergoing training at an external temperature of 28°C for about 90 minutes by intermittently pulling a light plow through loose soil

at a depth of only about 3cm, recorded a rise in body temperature of 3.2°C, from 38.2 to 41.4°C. Such increases are a cause of concern since the training involved minimal work (the plow was simply scratching the surface of well-tilled soil) and the

external temperature was much less than that experienced in the Fleuve. Project staff will now monitor animal temperatures before and after work, to find out how much useful work or training a buffalo can do before it needs to rest and wallow.

# Conclusions

## General

The project is highly innovative, and its small team has been attempting to develop a whole range of technologies at the same time. The project has demonstrated that water buffalo can survive, reproduce and undertake small quantities of work at Makhana station, while maintained under conditions of good management. It has yet to demonstrate that water buffaloes can survive, reproduce and work on small farms in the Delta, or that they can cope with the more severe climate found in the Fleuve, along the banks of the Senegal River.

The project has not differentiated between animal traction technology in general, and buffalo technology in particular. There has been no programme to compare buffaloes with alternative, indigenous animals such as cattle. This comparison is likely to be the most important, and crucial to the success of the project.

In the foreseeable future, water buffaloes will be valuable, expensive animals. Even if their initial importation cost (c. US\$6,000 per animal) and project overhead (say US\$20,000 per existing animal) is totally ignored, they will always be heavy animals requiring significant management and feed resources to raise. In the foreseeable future they will always be in short supply (assuming a demand exists), and so their economic price will be high. In such circumstances the cost of implements is unlikely to be a crucial factor limiting the success of the buffalo project.

## Choice of implement design

The project should not pursue attempts to copy the Thai plow. Local skills and facilities do not exist to readily produce wooden plows, and wooden plows have yet to be successfully introduced elsewhere in sub-Saharan Africa. The attempts to copy the Thai plow in steel have produced two inferior prototypes, and this has illustrated many of the problems that are faced when trying to develop a new plow. The well-meaning attempts of Jacob and Roosenberg (1987) and Roosenberg (1988) to design a new buffalo plow for Senegal are of little real relevance to the present project. The prototype developed from

the sketches has numerous problems, and it would take many cycles of modification and testing to develop a good prototype, and even longer to develop that into a production model, in the unlikely event that it proved superior to existing designs. The project has no agricultural engineer and no comparative advantages in equipment design and development. Short-term consultancies within the existing project structure would be unlikely to result in more than additional prototypes in need of further modifications and improvements.

In the short term the project should base its work on one of the SISMAR designs, such as the Houe Sine currently used by Projet FED at Podor, or the UCF, currently preferred for plowing in Casamance.

If harrowing and levelling are seen to be necessary and desirable, then implements should be tested in collaboration with other organizations. The comb-harrow and similar leveller has much to commend it, but it does not appear to have been used elsewhere in Africa. Thus projects elsewhere in the region, notably those in The Gambia and Mali, should be contacted to ascertain their experiences. Projet Hollandaise may assist in contacts with Projet Arpon, the large irrigation scheme in Mali.

## Choice of manufacturing materials

The project should not make it a point of principle to develop implements based on wood. While there are few, if any, recent examples of the successful introduction of locally-made wooden animal-drawn implements in sub-Saharan Africa, there are numerous examples of the successful manufacture and use of steel implements. Existing animal traction implements in Senegal are made of steel. The SISMAR factory is extremely well equipped to manufacture steel implements, and an infrastructure exists to maintain and repair these at village level. Good quality wood is in short supply in the Delta and Fleuve, and the area suffers from deforestation. At present there is no manufacture of wooden animal traction implements in the area, and to start such a programme would require significant human and financial resources. This is not justified at present. Thus, in the immediate future, plows should be made of steel. There may be a role for wood in the



construction of harrows and levelling boards. Wood should be used for yokes.

## Artisan manufacture and maintenance

The project should not make great efforts to work with local artisans at this stage, except in the manufacture of yokes. While artisans, particularly local blacksmiths, have the capabilities to repair and make animal traction implements, there is no real special demand relating to buffalo implements at present, and there is not likely to be in the near future. Most implements to be evaluated should be those readily available from existing sources, such as SISMAR. If there is a perceived need for other implements for evaluation, such as wooden harrows, then clearly local artisans should be approached to make them. In the longer term, should the project move into a new phase where buffaloes were proving successful and farmers were indicating the need for alternative implements and improved local support, then this would be a time to start to work closely with local artisans.

## Harnessing systems

The project should try training animals in pairs using a double withers yoke. Although straight yokes are widely used, and could be employed, there may be advantages in shaping the yoke to the curve of the animals' withers. Naturally such a yoke should be smooth. A double yoke will allow teams of buffaloes to be used that are significantly stronger than teams of local oxen, and will therefore maximise the size advantage of buffaloes. Single yokes, similar to the Thai design already in use at Makhana should be used where single animals are to be worked.

In general there should be much less emphasis on the development and evaluation of collars. While it would be very interesting to collect objective data on the comparative performance and acceptability of yokes, collars and breastbands, this should only be undertaken if staff time permits. The main objective of the project is the evaluation of the water buffalo, and this should have priority over trials with different harnessing systems. The present use of collars and breastbands represents an unnecessary complication in the evaluation of water buffaloes, and their comparison with work oxen.

## Programme of field testing

The testing of implements should not be a priority for the project. The project should issue farmers purchasing water buffaloes with implements that have already been proven to be effective in local rice production systems, and this implies the UCF plow or Houe Sine toolbar.

It should generally be assumed that in existing farming systems in the Delta and Fleuve, equipment suitable for rice production with draft animals will be the same whether oxen or buffaloes are employed. The draft capacity of a single large buffalo will be similar to that of a pair of oxen. In the event that pairs of buffaloes are employed, their power advantage over pairs of oxen can be expressed by their ability to walk faster and longer with existing implements, and so the provision of larger implements for buffaloes will not be required in the short term.

Apart from its stock of buffaloes, Projet Buffle does not have any important comparative advantages in field testing implements. It has no agricultural engineer and it does not have developed rice fields at Makhana equivalent to those of local farmers (its training area has been extensively cultivated already). It is therefore recommended that any programme of field testing of equipment to be used in the Fleuve be carried out in close cooperation with other projects, notably Projet FED, Projet Hollandaise and Projet Matam 3. It is likely that SISMAR would be interested in collaborating and in producing modified designs for testing. The agricultural engineer of ISRA-Saint Louis is likely to be able to provide much relevant advice in the implementation of such a programme. Since there are many more work oxen than buffaloes in the Fleuve, and market demand in the near future will come from oxen-based rice production systems, it is likely to be most satisfactory if the various implements and prototypes that exist are tested using oxen, possibly by Projet FED or Projet Matam 3. If alternative implements, such as the Rumpstad range, appear significantly better than the SISMAR implements, there would be a good case for issuing them to buffalo using farmers, but if there are only small differences, it would seem better to keep the evaluation of buffaloes separate from the evaluation of different implements.

Implements that might be tested include the standard SISMAR range (UCF, Houe Sine, Houe Occidentale etc), the Rumpstad implements held by Projet Hollandaise, various prototypes developed by SISMAR,

and various prototypes imported by Project Hollandaise. The prototypes held by Project Buffle, including Thai and Japanese plows and the CEEMAT Roliculteur could be included in the trials, but as mentioned, this should not be a priority for the project.

Although it is not suggested that the project take a leading role in any programme of testing and evaluating different implements, it might well take action to initiate and facilitate such a programme. This might be done by arranging a meeting of representatives of the projects concerned as well as ISRA and SISMAR to discuss possible collaboration on the testing of animal-drawn implements for rice production in the Fleuve. It might be appropriate to suggest that ISRA chair such a meeting, although it might well be held at one of the project sites.

### **Programme of information exchange**

The project has suffered from serious lack of knowledge of other animal traction initiatives elsewhere in the country, West Africa and in other parts of the world. This should be corrected as soon as possible. The consultant is pleased that project staff will be attending the forthcoming workshop of the West Africa Animal Traction Network being held in Nigeria in July. The project should use this opportunity to obtain as much information as possible on animal traction in general, and its use for rice production in particular. The project should make an effort to visit rice-production schemes in The Gambia and in Mali.

USAID should make an effort to obtain relevant information and documents for project staff, to increase their knowledge, and the chances of the project being successful.

### **Project recording and reporting**

It has been stressed that the project is highly innovative. For this reason particular attention should be paid to the detailed compilation and reporting of project experiences. It could be that the careful collection and analysis of data and experience, and its clear presentation as a major report could prove to be the most significant and long-lasting output of the project. The report envisaged, would detail the capabilities of the buffaloes, providing objective comparisons with alternative animals and power sources. Since the existing project staff have little experience of rigorous research, cooperation with other organizations would seem appropriate. In particular there

would be many advantages if ISRA were to be asked to be responsible for the objective work of collecting data (in close cooperation with project staff), while the duties of the project staff continue to be those of extension and training (which will inevitably involve a more subjective and promotional approach). There might well be scope for cooperation with other agencies more experienced in objective data collection such as the International Livestock Centre for Africa (ILCA), the Centre for Tropical Veterinary Medicine (CTVM) or AFRC-Engineering. Information to be collected and recorded would relate to reproductive performance, physiological response to work within local farming systems (body temperature, breathing and heart rate), speed of walking, power output, work achieved per unit time. Comparisons between buffaloes and oxen living and working in comparable conditions would be particularly valuable, and with this in mind, the possibility of on-farm research in Casamance might well be investigated. Economic and social data should also be carefully collected and analysed. Naturally the report would discuss quite frankly the various problems encountered in project implementation. Such a report could be considered as a follow-up to the BOSTID (1981) publication: a well-documented case history of how one country tried to implement the BOSTID recommendations. Such a report would have major benefits to other countries and donor agencies, and would be to the credit of all parties, and a clear "success" for the project.

Without such a publication, "success" may well prove elusive for the project, and all concerned. Naturally, in the event that buffaloes prove technically, physiologically, economically and socially acceptable to farmers in the Delta and Fleuve, and preferable to alternative power sources, and they increase rapidly in numbers, the project will be deemed by all concerned to have been a great success, and the results will speak for themselves. This, in the view of most people encountered on this mission, seems a relatively unlikely scenario given the present economic, climatic, nutritional, pathogenic and managerial constraints. If the animals all succumb to a calamitous disaster (such as disease outbreak, severe climatic stress or nutritional crisis following a major drought) then the project is likely to end with few recriminations on a rather fatalistic note. This is also unlikely given the success of the project to date. Another scenario, which could have been predicted from the start by studying other



schemes of introduction, is that the buffaloes will prove technically viable under high management conditions in areas of low climatic and disease stress, they will prove unadapted to very hot and dry areas, and to regions of major disease challenge, and that they will have little long-term impact on local farming systems due to slow population growth and lack of significant economic advantages over alternative options. In this latter case it would be difficult for USAID and GOS to know how long to support the Projet Buffle to give it a fair chance to prove itself. After an investment of two million dollars in the first and second phase, it would seem unreasonable not to support an extension or a third phase unless the project had either achieved its objectives or had been deemed to be a major failure (both unlikely on the basis of present evidence). And a fourth phase . . . ? And if external support were not forthcoming, what would GOS do with the remaining animals. Maintain them as an inbreeding

herd for years to come, or what?

Such problems may well have to be faced in the future, but in the meantime the present programme could continue, with similar general objectives, but with the additional goal of producing a well-documented case-history. As was stressed in a recent book entitled "Perfected yet rejected" (Starkey, 1988), a well-documented negative lesson represents a valuable contribution to development, and should not be considered a "failure". Negative lessons are only failures if people do not have a chance to learn from them. Provided the Projet Buffle documents its experiences well, it can prove to be a success for all concerned, whatever the final conclusions on the appropriateness, or otherwise, of buffaloes in the farming systems of Senegal.

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## Abbreviations and acronyms used

|                  |   |
|------------------|---|
| AFRC-Engineering | Institute of Engineering Research of the Agriculture and Food Research Council, Silsoe, United Kingdom        |
| CECI             | Centre canadien d'études et de coopération internationale, Montreal, Canada                                   |
| CEEMAT           | Centre d'études et d'expérimentation du machinisme agricole, Montpellier, France                              |
| CTVM             | Centre for Tropical Veterinary Medicine, Edinburgh, Scotland  |
| Dpt              | Département   |
| FED              | Fonds européen de développement (European Community Development Fund), Brussels, Belgium                      |
| GIE              | Groupement intérieur économique   |
| GOS              | Government of Senegal   |
| GTZ              | Deutsche Gesellschaft für Technische Zusammenarbeit (Germany bilateral aid agency)                            |
| ILCA             | International Livestock Centre for Africa, Addis Ababa, Ethiopia  |
| ISRA             | Institut sénégalais de recherches agricoles, Dakar, Senegal   |
| SAED             | Société nationale d'aménagement et d'exploitation des terres du Delta du Fleuve Sénégal, Saint Louis, Senegal |
| SISMAR           | Société industrielle sahélienne de mécaniques, de matériels agricoles et de représentations, Pout, Senegal    |
| USAID            | United States Agency for International Development  |

# Persons contacted

*(in chronological order of first encounter)*

Philip Jones, Agricultural Projects Officer, USAID  
Momadu Ba, Assistant Project Officer, USAID  
Moribadjan Keita, Agricultural Economist, USAID  
Jane Ellis, Project Officer, USAID  
Dr. Abou Mamadou Toure, Directeur de l'Elevage,  
Ministère de Ressources Animales  
Joseph Howell, Animal Traction Specialist, Projet Buffle,  
Saint Louis  
Dr. Yoro Ba, Acting Project Director, Projet Buffle,  
Saint Louis  
Malick Kane, Veterinary assistant, Projet Buffle,  
Saint Louis  
Dan Ho, Projet Buffle, Saint Louis  
M. Ahmadu Cisse, Division Promotion Rurale, SAED  
Delegation de Podor  
Jean-Jacques Bourge, Conseiller Technique Principal au  
Projet FED, SAED Podor  
M. Alex Amah, Responsable volet culture attelée, Projet  
FED, SAED Podor  
Alex Meerburg, Directeur du Projet, Projet Ile a Morphil  
Kas Burger, Chargé Traction Animale, Projet Ile à  
Morphil  
Michel Havard, Agricultural Engineer, ISRA  
M. Demba Ouman Sall, Président de la Communauté de  
Mboumba vis à Thioubralel, Dpt Podor (Potential  
buffalo farmer)  
Dr. Raphaël Coly, Vétérinaire chargé de la traction  
animale, Projet Matam 3, SAED Délégation Matam  
M. Samba Sow, Ox-using farmer, Hamaday Ounaré, Dpt  
Matam  
M. Abou Demba Tall, Ox-using farmer, Hamaday Ounaré,  
Dpt Matam  
M. Demba Lamine Ndiaye, Ox-using farmer, Hamaday  
Ounaré, Dpt Matam  
M. Oumar Yaya Deme, Farmer wishing to purchase a  
buffalo, Ndouloumadju Dembé, Dpt Matam  
M. Malick Mar, Forgeron, Quartier Balacos, Saint Louis  
M. F. M. Diallo, Société Industrielle de Ferlo, Quartier  
Léona, St. Louis  
M. Saliou Niang, Thilène (Seller of animal traction  
implements)  
M. Khamb Ard Sakkal, N'Gensaar (Purchaser of animal  
traction implements)  
M. Gola Thiam, Forgeron, Rosso Bethio  
M. Moustapha Mbengue, Président de GIE Alphahi  
Mayoro Welle, Bokol, Dpt Dagana (Head of village  
group that has purchased buffaloes)  
M. Nourou Diop, Oxen-using farmer, Foonolé As, Dpt  
Podor  
Tidiene Diao, Volet Traction Animale, Projet Ile à  
Morphil  
Siegfried Tluczkont, Mission Forestière Allemande,  
Saint Louis  
Marlene Richter, Conseiller en Développement Villageois,  
GTZ, St. Louis  
M. Sidi Moctar Keita, Président-Directeur, SAED

# Mission itinerary

## Monday 28 May

Travel Reading, London, Rome Dakar

## Tuesday 29 May

Meetings with staff of USAID, Dakar  
Meeting with Directeur de l'Elevage

## Wednesday 30 May

Discussions Animal Traction Specialist, Projet Buffle  
Visit SISMAR, Dakar and SISMAR, Pout  
Travel to Saint Louis

## Thursday 31 May

Site visit, Makhana Farm, base for Projet Buffle  
Discussions with staff of Projet Buffle  
Farm visit near Savoigne to see first buffaloes on a farmer's holding  
Discussions with Agricultural Engineer, ISRA-Saint Louis

## Friday 1 June

Site visit and discussions, Projet FED, Podor  
Site visit, discussions and demonstrations, Projet Ile à Morphil ("Projet Hollandaise")  
Village visit Mboumba vis à Thioubralel, Dpt Podor and discussions with farmer interested in purchasing buffaloes

## Saturday, 2 June

Site visit and discussions, Projet Matam 3, SAED Délégation Matam  
Village visit and discussions with oxen-using farmers in Hamaday Ounaré, Dpt Matam  
Farm visit and discussions with potential water buffalo farmer in Ndouloumadju Dembé, Dpt Matam

## Sunday 3 June

Visit animal traction suppliers at weekly market (marché hédomadaire de Dodel, Département Podor)

## Monday 4 June

Site visit Makhana Farm and discussions with staff of Projet Buffle

## Tuesday 5 June

Site visits and discussions with local artisans and workshops, Saint Louis  
Discussions with farmers buying and selling second hand animal traction implements  
Site visit and discussions with local blacksmith, Gola Thiam  
Farm visit, GIE Alphahi Mayoro Welle, Bokhol, Dpt Dagana

## Wednesday 6 June

Site visit, Diomandu (Projet FED)  
Village visits and discussions, Foonolé As, Département de Podor  
Site visit and discussions, Projet Ile à Morphil ("Projet Hollandaise")

## Thursday 7 June

Discussions with staff of Projet sénégallo-allemand de reboisement et d'aménagement sylvo-pastoral de la zone nord  
Site visit Makhana Farm, review of implements tested and discussions with staff of Projet Buffle

## Friday 8 June

Review of project documents and relevant papers (the activity programme for the day was cancelled due to the sudden death of a member of the project).

## Saturday 9 June

Site visit Makhana and discussions with staff of Projet Buffle  
Farm visit Savoigne and observations of two buffaloes working on the farm of their new owner, Balla Kane  
Farm visit Bango, and observations on demonstration plots prepared by buffaloes

## Sunday 10 June

Review of documents and report preparation

## Monday 11 June

Site visit Makhana and discussions with staff of Projet Buffle  
Discussions, Agricultural Engineer, ISRA  
Discussions, Président-Directeur, SAED

## Tuesday 12 June

Travel Saint Louis - Dakar  
Discussions staff of USAID

## Wednesday 13 June

Report preparation  
Discussions staff of USAID

## Thursday 14 June

Report preparation

## Friday 15 June

Meetings USAID and presentation of report

## Saturday 16 June

Travel Dakar-Geneva-London-Reading

# Some contact addresses

## *Australia*

**ACIAR-Draught Animal Power Project,  
Graduate School of Tropical Veterinary Science, James  
Cook University, Townsville 4811,  
Queensland, Australia. Telex 47009 UNITOWN AA**

The Coordination Unit of the ACIAR-supported Draught Animal Power Project is based at James Cook University. Research topics include the nutrition of working buffaloes and small numbers of fistulated buffaloes have been trained for work. Other areas of research interest include health and reproduction and farming systems research relating to animal traction. The DAP Project liaises with draft animal programmes in several southeast Asian countries, and has particularly strong links with research programmes in Indonesia. It publishes the DAP Project Bulletin twice a year, with several articles relating to buffaloes. It assisted the convening of the second ACIAR international workshop on draft animal power in Indonesia in 1989, the proceedings of which were published by ACIAR (Box 1571 Canberra ACT 2601, Australia). Contact: *E. Teleni* (Coordinator).

## *Ethiopia*

**International Livestock Centre for Africa (ILCA), P.O.  
Box 5689, Addis Ababa, Ethiopia  
Telex: 976-21207 ILCA ET**

ILCA is an international research centre, with its headquarters in Ethiopia. ILCA has a very strong interest in draft animals and has a specific animal traction research "thrust". Studies on draft animal nutrition, equipment and systems of utilization have been carried out in Ethiopia, Niger, Nigeria and Mali. ILCA's library contains numerous documents relating to draft animals which have been listed in its animal traction bibliographies and bibliographic databases. ILCA's information department may assist research scientists in Africa to obtain photocopies or microfiches of relevant documents. ILCA is promoting the concept of Animal Traction Research Network(s) which aim to stimulate collaboration between different national and international research programmes. The animal traction thrust of ILCA is now based in Nigeria.

## *France*

**Centre d'Etudes et d'Expérimentation du Machinisme  
Agricole Tropical (CEEMAT), Domaine de la Valette,  
73 rue J. F. Breton, 34000 Montpellier, FRANCE**

CEEMAT is an agricultural engineering research and training institute sponsored by the French government through CIRAD. CEEMAT has long been associated with the development of animal traction, most notably in francophone

Africa, but also in several countries in Asia and Latin America. Work includes the design and testing of alternatives to mouldboard plows including animal-drawn tines and rolling cultivators, economic studies, an animal traction bibliography and guidelines for rural workshops. It produces the quarterly journal *Machinisme Agricole Tropical*. CEEMAT also provides the European Secretariat for the agricultural engineering network ACEMA (Association Euro-Africaine des Centres de Mécanisation Agricole). CEEMAT is currently working in cooperation with ISRA in the testing of agricultural implements in Senegal, and has cooperated with AFRC-Engineering, UK, in the development of data-loggers suitable for use in the field. Contact: *Gérard Le Thiec* (Animal traction specialist).

## *The Gambia*

**Ministry of Agriculture, Central Bank Building,  
Buckle Street, Banjul, THE GAMBIA  
Telex: 2256 FAO GV**

**Department of Agriculture, Cape St. Mary,  
THE GAMBIA**

**Agricultural Engineering Unit, Department of  
Agriculture,  
Yundum Experimental Station, Yundum,  
THE GAMBIA**

**Agricultural Research Station, Sapu, M.I. Division,  
THE GAMBIA**

**Soil and Water Management Unit (SWMU),  
Department of Agriculture, Yundum, THE GAMBIA**

**Department of Animal Health and Production, Abuko,  
THE GAMBIA**

The Gambian Ministry of Agriculture is responsible for most animal traction activities in the country, including irrigated schemes for rice production. The Department of Agriculture has a network of District Extension Centres which were initially developed as ox-training centres and still provide extension, training and equipment supply services. The Agricultural Engineering Unit at Yundum has responsibility for research and development relating to animal draft, and it has been carrying out equipment testing and development work at Yundum for many years. Several other departments and units are involved in animal traction work, including SWMU which is interested in aspects relating to soil erosion and moisture conservation. The research station at Sapu has carried out comparative trials using work oxen. Contacts include: *Mr. Papa Cham*, Chief Agricultural Engineer.

**The Gambian Agricultural Research and  
Diversification Project (GARD),**



**Department of Agriculture, Cape St. Mary,  
THE GAMBIA  
or c/o USAID, P.O. Box 2596, Banjul, THE GAMBIA**

GARD is a USAID-assisted development project supporting work on animal traction in The Gambia.

### *India*

**Central Institute for Research on Buffaloes, Sirsa  
Road, Hisar-125001, Haryana, India**

Research institute, mainly concerned with riverain (dairy) buffaloes. Contact: *Dr. V. D. Mudgal*.

### *Indonesia*

**Draught Animal Power Project, Balai Penelitian  
Ternak, P.O. Box 123, Bogor, Indonesia**

Research project, working with support from Australia's ACIAR DAP Project. Hosted the 1989 international workshop on draft animal power, with considerable information on the use of buffaloes. Contact: *Dr. M. Winugroho*.

### *Mali*

**Projet ARPON (Amélioration de la riziculture  
paysanne à l'Office du Niger),  
B.P. 1, Niono, MALI**

The "Office du Niger" in Mali is promoting the use of animal traction for irrigated rice production through a number of projects. By 1986, 40 000 ha of irrigated rice were cultivated by 25 000 work oxen, but the potential for increase is reported to be considerable. The primary project (ARPON) is the largest Dutch aid project in Africa, and in 1986 it opened a workshop to fabricate plows and harrows. It has recently cooperated with equipment manufacturing firm of Rumpststad in The Netherlands. Activities include the purchase of cattle from pastoral herds for supplying to the local farmers, equipment evaluation and development and some research on fodder production.

### *The Netherlands*

**Larenstein International Agricultural College,  
Brinkgeversweg 69, P.O. Box 7, 7400 AA, Deventer,  
The Netherlands**

The Department of International Agricultural Education of Larenstein International Agricultural College (often still known as Deventer College) organizes several courses relating to tropical agriculture including one course specifically relating to draft animal power and harnessing techniques. Contacts: *Gijs den Hertog* and *Jan van Huis* (Senior lecturers).

**Rumpststad B.V., P.O. Box 1, 3243 ZG Stad aan't  
Haringvliet, The Netherlands**

Rumpststad is a commercial manufacturer of agricultural equipment in The Netherlands. It has been working with several organizations in Africa to develop equipment de-

signs that can be locally manufactured by blacksmiths or small workshops. It has worked with Projet ARPON in Mali. At one time it was prepared to send samples of its equipment free-of-charge to organizations willing to provide technical feedback. Contact *K. B. van Dam* (Director).

**Technical Centre for Agricultural and Rural  
Cooperation (CTA), De Rietkampen, Galvanistraat 9,  
Ede, Postbus 380,  
6700 AJ Wageningen, The Netherlands**

CTA financed by the EEC and based in The Netherlands is involved in gathering and disseminating information relating to rural development in tropical Africa and elsewhere. Animal traction is an area of interest of CTA and it is publishing animal traction books in cooperation with CIRAD (France) CTVM (UK) and the West Africa Animal Traction Network.

### *Nigeria*

**International Livestock Centre for Africa (ILCA),  
Sub-Humid Programme, P.O. Box 2248, Kaduna,  
NIGERIA.**

**Telex: 71384 ILCAKD NG Phone: 21 19 82**

ILCA's Sub-Humid Zone Programme in Nigeria is now the base for ILCA's Animal Traction Thrust. Contacts include: *Ralph von Kaufmann* (Thrust Coordinator), *Dr. Peter Lawrence* (Networking representative and specialist in measuring the work output of draft animals) and *Hans Jansen* (Agricultural Economist).

### *Senegal*

**Institut Sénégalais de Recherches Agricoles (ISRA),  
B.P. 3120, Dakar, SENEGAL**

**ISRA Département Systèmes, ISRA-Saint Louis, B.P.  
240, Saint Louis, SENEGAL**

ISRA is a large research organization within the ministry of rural development and its farming systems department is carrying out research on animal traction in several parts of the country. ISRA has produced many reports on animal traction equipment and on socio-economic aspects of animal power. Contacts include: *Michel Havard*, Agromachiniste, ISRA-Saint Louis.

**SISMAR (Société Industrielle Sahélienne de  
Mécaniques, de Matériels Agricoles  
et de Représentations), B.P. 3214, Dakar, SENEGAL.  
Telex: 7781 SISMAR SG Phone: 51 10 96 (Pout),  
21 24 30 (Dakar)**

SISMAR has a factory at Pout, about 100 km from Dakar, and is one of the largest manufacturers of animal traction equipment in Africa. SISMAR was formed after the financial problems of the previous manufacturing company "SISCOMA", by which name much of its equipment is still known. Due to limited local demand (associated with limited credit availability), it is still running well below its



large capacity. It is most famous for the Nolle-designed multipurpose Houe Sine toolbar and the Super Eco seeder which have been widely sold both within Senegal and in neighbouring countries. SISMAR is interested in developing plows that are well-adapted to rice cultivation. Contacts include: *M. Birame Ngoye FALL* (Directeur Commercial).

**SAED, B.P. 74 Saint-Louis, Senegal  
Telex 75124 SG Phone 61 13 80**

SAED (Société nationale d'aménagement et d'exploitation des terres du Delta du Fleuve Sénégal) is responsible for agricultural development initiatives along the Senegal river in the north of the country. It is responsible for several projects with animal traction components and is interested in potential for collaboration in this field. Contact: *M. Sidi Moctar Keita* (Président-Directeur).

**Projet FED, SAED Podor, B.P. 36, Podor, Senegal**

"Projet FED", with technical cooperation and financial support from the European Community, operates within the framework of SAED in Département de Podor. It is levelling land for irrigated rice production and is promoting the use of animal traction for farmers with small areas of irrigated land. In 1989 it provided 369 pairs of oxen on credit. The project is interested in the development of equipment suitable for cultivation of rice swamps and is cooperating with SISMAR in this regard. Contacts include: *M. Jean-Jacques Bourge* (Conseiller Technique Principal) and *M. Alex Amah* (Responsable volet culture attelée).

**Projet Ile à Morphil ("Projet Hollandaise"),  
B.P. 299 Saint Louis, Senegal**

Projet Hollandaise is supported by Dutch technical cooperation and operates within the overall framework of SAED. It is involved in developing the agricultural production of Ile à Morphil, notably through the establishment of irrigated fields for rice production. It tried to promote the use of draft oxen, but found the response was unenthusiastic. This was attributed primarily to the limited feed resources on the island and the near absence of cattle. The project has recently concentrated on the potential for donkey traction and is currently both testing and promoting a novel system of hitching three donkeys to a plow, using collar harnesses and a system of eveners. The project has a large range of equipment for testing and is interested in cooperating with other projects in the development of suitable animal traction packages for rice production in the Fleuve. Contacts include: *Alex Meerburg* (Directeur du Projet) and *Kas Burger* (Chargé Traction Animale).

**Projet Matam 3, SAED Délégation Matam, B.P. 85  
Matam, Senegal**

Matam 3 improvement project is administered by SAED with funding from Italy and the Kingdom of Abu Dhabi. It is developing a large areas of land suitable for irrigated

rice cultivation and has recently started to promote the use of work oxen for rice cultivation and transport. Contacts include: *Dr. Raphaël Coly*, Vétérinaire chargé de la traction animale.

**Tanzania**

**Usangu Village Irrigation Project, (FAO: URT/80/011),  
P.O. Box 336, Mbeya, Tanzania.**

An irrigation project that has been evaluating the use of a small number of male buffaloes derived from a breeding herd of of the Egyptian type. Contacts include: *Mr. Metakohy* (Chief Technical Adviser), *Mr. Iddi Kinyaga* (Tanzanian agricultural officer) and *Mr. Manuel Lecca* (FAO Extension specialist).

**Thailand**

**International Buffalo Information Centre (IBRC),  
Kasetsart University, Bangkok, Bangkok 10900,  
Thailand**

Major world resource centre for buffalo information. Publishes Buffalo Bulletin quarterly.

**United Kingdom**

**Overseas Division, AFRC-Engineering,  
Wrest Park, Silsoe, Bedford MK45 4HS, UK  
Telex: 825808 G**

The Overseas Division of AFRC-Engineering (formerly NIAE) has been involved in animal traction implement development for many years. Recently it has been developing techniques and instrumentation for measuring and logging many of the mechanical and physiological parameters associated with animal draft. Field trials with draft animals are being undertaken in cooperation with national and international institutions in Africa and Asia. It is hoped to use the information obtained from the data loggers to develop a scoring system to facilitate the comparison of different animals and implements. Contacts include: *Brian Sims* (Head of Animal Traction Programme) and *Dave O'Neill* (a key researcher in the development of the measuring equipment).

**Centre for Tropical Veterinary Medicine (CTVM),  
Easter Bush, Roslin, Midlothian EH25 9RG, Scotland,  
UK Telex: 727442 UNIVED G**

The CTVM of the University of Edinburgh is carrying out research on the nutritional and physiological implications of draft work, using cattle, buffaloes, horses and donkeys. Several interactions are being studied including nutrition-work, work-milk production and work-disease, and it is hoped to establish criteria for selecting draft animals. CTVM has developed equipment and techniques to establish work output under both controlled and field conditions. CTVM publishes "Draught Animal News" twice a year. It runs courses on animal traction, in cooperation with Deventer College in The Netherlands. Contacts in-

clude: *Dr. A. Pearson* who has published work on the effect of heat and disease on the work output of buffaloes.

**International Buffalo Federation, c/o Dr. W. Ross  
Cockrill, 29 Downs Park West, Bristol BS6 7QH, UK**

IBF, with its secretariat in Egypt, is organizing the third world buffalo congress in Varna, Bulgaria, in May 1991. Contact: *Dr. M. R. Shalash* (President) in Egypt or *Dr. Ross Cockrill* in UK.