Eradicating the New World Screwworm from the Libyan Arab Jamahiriya

A look at how an international programme protected North Africa's wildlife and livestock from a "worm of death"

by D.A. Lindquist and M. Abusowa

In the spring of 1988, severe cases of myiasis—an infestation of animal wounds—were found in livestock in the Libyan Arab Jamahiriya. The larvae causing these myiasis cases were sent to the British Museum of Natural History for identification. When identified as the New World Screwworm, *Cochliomyia hominivorax*, very few people in either Libya or Europe felt concern. This was not surprising since there was little or no experience with this parasite there.

The few individuals in Europe with New World Screwworm (NWS) experience, primarily within United Nations organizations, reacted vigorously. Along with people in the Americas, they soon alerted Europeans and North Africans about the enormous potential danger that the NWS presented for livestock, wildlife, and people of Africa, the Middle East, and Southern Europe. *(See map.)* In a short time, extensive media coverage about the threat of the NWS to the Old World had helped secure strong public support to solve the problem.

At the international level, the Food and Agriculture Organization of the United Nations (FAO) confirmed the presence of the parasite in Libya in the spring of 1989. This meant that the NWS had survived the 1988-89 winter in Libya, and would pose a serious threat if not controlled. That realization marked the starting point for the actions subsequently taken by the international community to support the Libyan effort to eliminate the NWS from North Africa.

The NWS eradication programme

In early 1989 the Government of Libya made a decision to rid the counry of the screwworm. The decision was backed with strong financial and political support, and based on the knowledge that NWS eradication had been successful in the USA and Mexico, and that it was feasible in Libya.* The Libyan Veterinary Services, which was assigned the responsibility of NWS eradication by Libyan authorities, mounted an effective programme of surveillance and control before the FAO or other UN organizations became directly and fully involved.

Planning was done by the FAO and IAEA over several months. The plan consisted of a number of interrelated components: surveillance, control, quarantine, the sterile insect technique (SIT), epidemiology, and information/communications. Supporting activities included laboratory identification of larval and adult samples, small-scale NWS rearing, limited research and development, equipment maintenance, and administration.

This article highlights key aspects of the programme, which proved successful in protecting North Africa from the NWS threat. The last case of NWS in Libya was recorded on 7 April 1991—compared to a high of more than 12 000 cases in 1990—and in June 1992, the Libyan government officially announced the eradication of the parasite from its territories.

Surveillance activities

The determination of where the screwworm existed in Libya and a reasonable estimate of the density of the infestation was obtained through

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* Detailed accounts about the NWS and its eradication appear in the October 1991 edition of *World Animal Review*, a periodical of the FAO, Viale delle Terme di Caracall, 00100 Rome, Italy. Readers also may be interested in the document, *A Programme for the Eradication of the New World Screwworm from North Africa*, a report published by the IAEA in April 1990; and in the book, *The New World Screwworm Eradication Programme·North Africa 1988-92*, published by the FAO in 1992.

extensive surveillance. Whereas in the New World, surveillance was done primarily by owners of livestock who inspected their animals and sent in larval samples, veterinary teams of the Libyan Veterinary Service were responsible for doing this in the North African programme.

Starting with about 40 teams in mid-1989, surveillance activities increased to 94 teams by mid-1990 and surpassed 100 teams by mid-1991. Each team consisted of three individuals with a vehicle, larval sampling equipment, and insecticide for wound treatment and spraying livestock. A team was assigned a specific route which was covered each 21 to 28 days. All livestock within the team's assigned area was inspected. Systems for data management, sample handling, etc., were developed and implemented. Maps were obtained on which grids were established to determine the exact coordinates of NWS myiasis cases.

Control and quarantine activities

Surveillance teams carried out control treatments by spraying livestock, primarily sheep, and treating individual animal wounds. As the programme advanced, spraying of animals was reduced and teams primarily treated wounds, regardless of whether they were infested by NWS. The insecticide used, coumaphos, had some residual activity and would prevent newly laid eggs from establishing a myiasis.

Quarantine activities were initially conducted by using "check points" for intercepting, inspecting, and treating livestock being transported within and outside the infested area. By December 1990, 11 quarantine stations had been established, primarily at the periphery of the infested area to prevent NWS infested animals from being transported into adjacent non-infested areas. The quarantine stations consisted of caravans which could be moved if necessary. Initially the stations were manned during daytime only. But by late spring 1991, they were operated around the clock.

Training of the quarantine staff was carried out within Libya. Appropriate legal requirements were developed and implemented. Each quarantine station had a vehicle, larval collection equipment, insecticide for wound and spray treatment, and equipment which was used to spray animals leaving the infested area.

The sterile insect technique (SIT)

The decision to eradicate the NWS from Libya required the use of the sterile insect technique (SIT). This technique — the only eradication technology available—has been used operationally for NWS eradication in the Americas for more than 25 years.

The SIT is a radiation-based technology that involves mass rearing and sexual sterilization of the target species, which are then dispersed throughout infested areas. A female mating with a sterile male will produce no progeny, and over time the insect population declines.

To be effective, SIT requires the continuous dispersal of millions of high-quality sterile insects over the entire infested area for several generations. Since the sterilized males do not kill the native insects but merely mate with the females, population decline is not rapid. Interruption of dispersal can have disastrous effects, since insects in the wild will continue to mate. If no sterilized males flies are released for one week early in the eradication programme, it may require two extra months of dispersal to restore sterility in the wild insect population to the level it was before the interruption. Thus, great care must be taken to assure that dispersals take place on a regular schedule without gaps. NWS eradication requires two releases of millions of flies per week.

In Libya, one of the first things that had to be done was to confirm the mating compatibility of the Libyan and Mexican NWS strains. This was accomplished by collecting pupae in Libya and transporting them to Fargo, North Dakota, in the United States. There, tests were conducted at a laboratory of the Agricultural Research Service of the US Department of Agriculture. The strains were found to be completely compatible.*

Among the early decisions made was whether sterile NWS should be purchased from Mexico or whether a new NWS mass-rearing facility should be built in the Old World. Because of the high cost and time required for construction, organizers decided to purchase the insects from the Mexican-American Commission for Eradication of Screwworms (MACES). It operates the only NWS mass-rearing plant in the world at Tuxtla Gutierrez, Chiapas, Mexico.

Plans were made for aerial shipment of millions of sterile NWS from Mexico to Libya. Transport of NWS over such a great distance had never been attempted and was one of the main potential problems. However, preliminary tests by the IAEA indicated that it would be possible. Because of the absolute necessity of having

*"Reproductive compatability and mitochondrial DNA restriction site analysis of New World Screwworm, *Cochliomyia hominivorax*, from North Africa and Central America", D.B. Taylor, L. Hammack, and R.L. Rochrdanz, *Medical and Veterinary Entomology*, 5, 145-151 (1991).

Sometimes called "the worm of death", the New World Screwworm historically has been one of the most destructive and costly insect pests of warm-blooded animals in the western hemisphere. Its discovery in Libya in 1988 presented grave health and economic risks for the country and surrounding regions.

The fly itself is harmless. Its reputation as a deadly parasite comes instead from its larvae, which are totally dependent on the living tissue of host animals for survival. The wound they cause is known as myiasis, the presence of dipterous larvae in the tissues of animals or humans.

The cost of living with the NWS, in terms of surveillance and animal treatment, animal death, and loss of production, is enormous. Even when an infested animal does not die, it is more susceptible to other diseases, and milk and meat production can be seriously affected. Damage to hides and the cost of inspection and treatment amount to significant economic losses to livestock owners. Based on an annual cost range of US $4 to $10 per animal for inspection and treatment against NWS, it was estimated that living with the pest would cost Libya more than US $28 million annually. The five countries in the North African region, with 70 million head of livestock, would incur a combined cost of US $280 million annually.

The international NWS eradication programme in North Africa prevented such consequences because of its rapid, efficient implementation. Originally estimated to cost US $117.5 million in 1990, the actual eradication programme was completed in 1 year instead of 2 at a cost of US $66.6 million.

An independent study on the economic impact of the screwworm in North Africa put the annual regional benefit of eradication at more than US $300 million. It showed a benefit/cost ratio for the region of 50:1.

Under the main eradication programme, 28 million sterile flies were initially dispersed weekly over the entire known infested zone, an area of 26 000 square kilometres in northwestern Libya. Treatment was later expanded to include a protective barrier around this zone, including an area of approximately 2500 square kilometres on the zone's western edge inside Tunisia. The number of flies dispersed was increased to 40 million every week.

In assisting this international effort, the IAEA played a major support role in the screwworm campaign. Its work ranged from supporting testing and research activities, including the study of different strains of NWS and trial shipments of sterile NWS pupae from Mexico to study the effects of shipment on fly quality, to the provision of technical expertise and facilities of its Seibersdorf Laboratories.

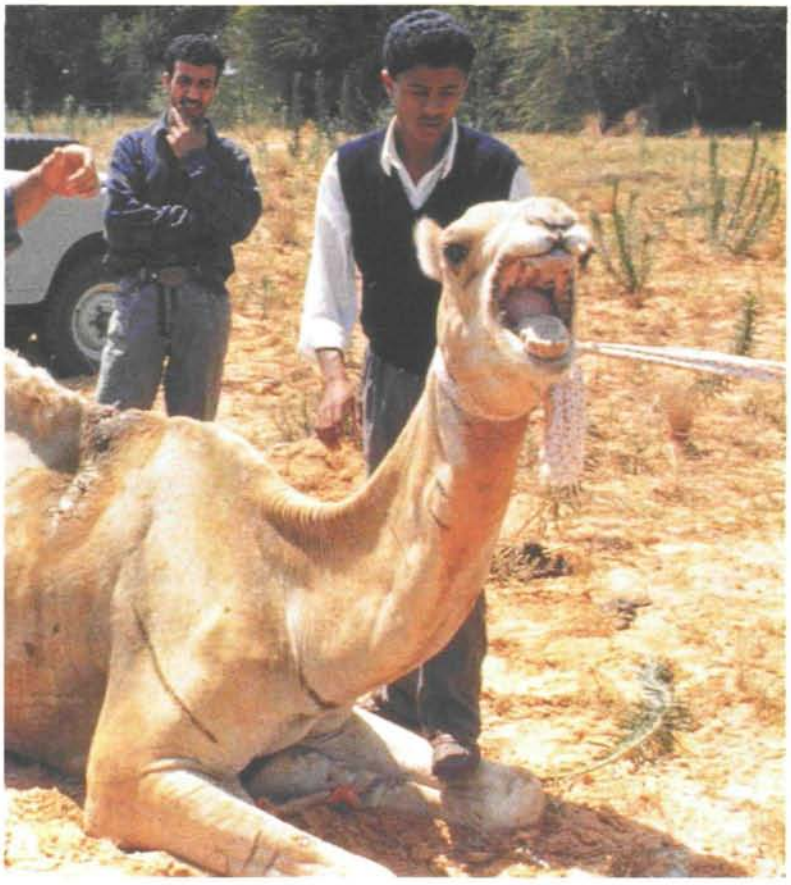
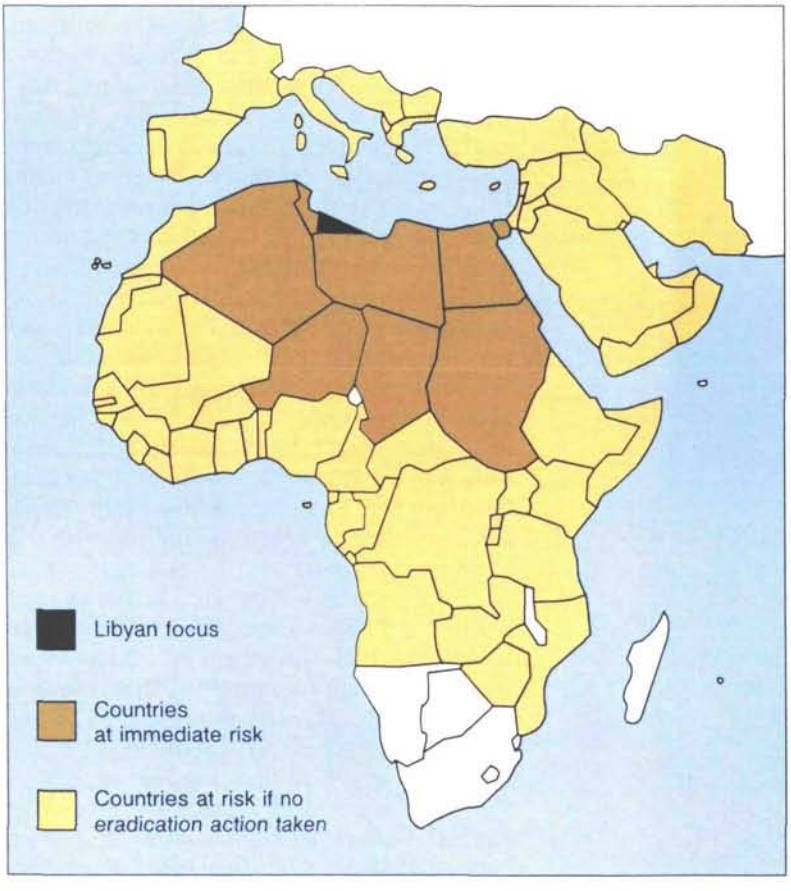


Photo: Libyan farmers examining a camel for NWS infestation. (Credit: FAO)



enough high-quality sterile flies for two dispersals per week, significant effort went into planning these shipments.

Much needed to be done: Facilities had to be developed to handle the large numbers of sterile NWS to be received in Tripoli, people had to be trained, aircraft had to be arranged, and monitoring systems set up, for effective dispersal.

Quality-control tests were conducted on each batch of sterile NWS received from Mexico. Each shipment consisted of three to eight batches, totalling 3.5 million per week early in the programme and increasing to 40 million per week later on. Identical tests were conducted in Mexico and Libya on the same batches of flies. The data clearly showed that the quality of the flies dispersed in Libya was comparable to those dispersed in Mexico and Central America.

As a result of such steps, the method of transporting and handling hundreds of millions of sterile NWS from Mexico to Libya was accomplished with no significant problems.

During programme planning, a decision also was taken to keep the handling of the sterile NWS in Libya as simple as possible. Consequently, preparations for dispersing sterile flies were done in Mexico to the greatest possible extent, including packaging the sterile NWS in special boxes containing a jell of glucose and water. Although this increased the volume shipped from Mexico, it resulted in relatively simple operations in Libya. The alternative—shipping sterile NWS pupae in bulk and packaging them in Libya—would have been far more costly. It would have required obtaining complex packaging equipment (including maintenance capability); temperature-controlled space for packaging; temperature-controlled vehicles to transport high volumes of boxed sterile NWS from the packaging centre to the distribution centre at the Tripoli airport; and employment and training of additional staff.

One consideration primarily influenced the decision to package the sterile NWS in Mexico and reduce handling to a minimum in Libya. This was the absolute necessity of minimizing the risk of not having enough high-quality sterile NWS on hand in Libya for the required two dispersals each week.

Release of sterile flies began in mid-December 1990 with 3.5 million dispersed over 25% of the infested area. This was increased to 7.5 million by the first of January 1991. These releases, made once a week, were in preparation for the full eradication phase. That phase began during early February 1991 when 28 million sterile flies were received weekly. These were released twice a week over the entire infested area, which covered 28 000 square kilometres. The number of flies released increased to 40 million a week in early May 1991. These were dispersed over an area of 40 000 km^2, which included a biological barrier of about 15 000 km^2 to the east, south,and west of the infested area.

Sterile fly releases ended on 18 October 1991, more than six months after the last NWS infested animal had been detected on 7 April 1991. A total of 1300 million sterile flies had been released between mid-December 1990 and mid-October 1991.

Epidemiology and R&D

The epidemiology required for the NWS eradication programme in Libya was not classical.

Data from surveillance, quarantine, fly traps, vegetation, climate, livestock numbers, and quality and quantity of available sterile flies—all were interpreted within the context of what was known about NWS eradication technology. Decisions were made daily. Adjustments in numbers of sterile flies dispersed in a given area were based on the interpretation of available data. Judgements were grounded in empirical knowledge of what would work and not work in NWS eradication programmes.

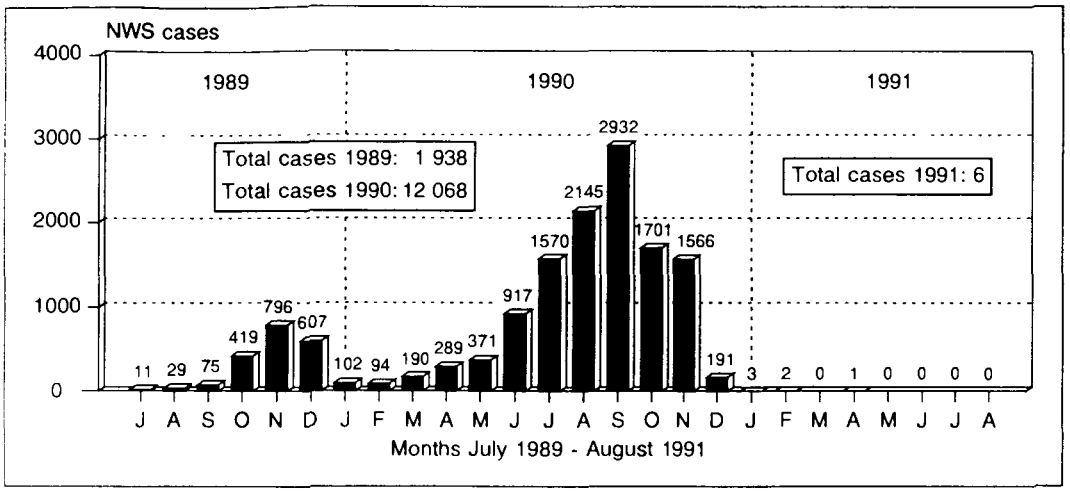
The epidemiological activity of the Libyan programme thus was central to the decision-making process. All other technical activities revolved around, and fed data into, the epidemiological analysis.

Research and development. Virtually no research was conducted in Libya which had a direct influence on the NWS eradication programme.

Simple tests were designed occasionally to verify certain aspects. These related to slightly modifying the dispersal chute so that the boxes of sterile flies did not hit the tail or fuselage of the dispersal airplane; applying a rapid method of accurately measuring adult emergence of the sterile insects upon receipt from Mexico; measuring dispersal of sterile flies, as well as their longevity in the wild; and determining maximum temperature/time durations for sterile NWS pupae to provide information for emergency handling of sterile insects in case of a shipment problem. It is anticipated that most of the data from these tests will be published.

Information and communication

A job as visible as the one to eradicate a "worm of death" from Libya required the support of the public and of the livestock owners. Without such backing, it would have been im-



Cases of New World Screwworm in Libya, July 1989-August 1991

possible to obtain data on disease incidence, or to treat the infested animals or operate an effective quarantine/animal movement control programme. The general public was informed about the SIT and about boxes of sterile NWS that would be released from low-flying aircraft on a regular basis. Public opposition to this procedure had to be avoided at all costs.

An active information campaign was initiated by mid-1989. It was headed by a Libyan veterinarian, thereby assuring technical accuracy. Leaflets, posters, videos, and live radio and television broadcasts were the main communication channels. Other approaches also were used to keep the general public and livestock producers in Libya well informed about the NWS problem and about progress through the eradication programme. Contact with livestock owners was established primarily through their livestock associations, and with the general public through fairs, schools, and other public activities.

These essential ingredients helped to make the information and communications part of the NWS eradication programme work effectively.

Rapid, effective response

When most of the international staff arrived in Libya during October and November 1990, there was very little time to get ready for the initiation of the eradication programme. Their work was aided by excellent Libyan staff, who were appointed in September 1990 and rapidly became proficient in all of the programme's aspects. By January 1991, all essential elements to eradicate the NWS from Libya had come together. The international and Libyan staffs were prepared, essential equipment and supplies were on site, and sterile flies were arriving from Mexico.

Fortunately, everything was ready in time to take advantage of cooler than usual winter weather during late December 1990 and January 1991. This cool weather caused a dramatic decline in NWS populations. The first dispersal of sterile NWS throughout the infested area started during the first few days of February 1991, when most of the NWS were pupae in the soil. When the wild NWS adults did emerge during the following weeks, they were greeted by an overwhelming ratio of sterile flies.

The last recorded case of NWS in Libya was on 7 April 1991, and all told only six cases occurred during 1991. During 1989 and 1990, before the full eradication programme began, more than 14 000 cases had been recorded. *(See graph.)*

By being prepared to apply the SIT at a time when favourable weather conditions affected NWS populations, the eradication programme saved one year of operation and many millions of dollars.

Reasons for success

The successful result of the programme in Libya provides some answers to questions about managing and implementing such endeavours.

When it comes to an eradication programme, there is either success or failure, and nothing in between. Technical and managerial decisions must be made to reduce the risk of a major mistake to an absolute minimum. In planning and implementing the Libyan programme, the two overriding considerations were: containing the NWS within Libya to eliminate the extreme difficulty of conducting operations in more than one country; and doing everything possible to make sure that enough high-quality sterile flies would be available for uninterrupted weekly dispersals over the entire infested area.

As these scenes suggest, the international programme to eradicate the New World Screwworm (NWS) from North Africa was a multi-disciplinary effort involving people throughout the world, from farmers and researchers in Libya to suppliers in Mexico. By the time the first shipment of 10.5 million sterile flies arrived in Tripoli in February 1991, the programme's preparatory phase had established the groundwork for the SIT campaign. Just over nine months later, following the release of more than 1300 million sterile flies, supported by intensive surveillance, treatment, and quarantine activities, the SIT programme was brought to a successful conclusion. Sterile fly releases ended in October 1991, six months after the last case of screwworm myiasis had been found.

This page *(clockwise from bottom left):* a Libyan farmer receives packets of insecticide to treat the wounds of his animals and protect them from NWS attack; information materials on NWS control are reviewed before distribution to Libyan livestock producers; Libyan children in the countryside release sterile NWS from a box that did not open when dropped from aircraft; packaging sterile NWS in Mexico for shipment to Libya.

Facing page *(clockwise from top left)*: Boxes of sterile NWS are loaded into airplanes for aerial release; a few of the millions of sterile flies released during the campaign; as part of quality control tests, a Libyan laboratory assistant dissects trapped female NWS flies to determine if they are sterile. (Credit: All photos courtesy of FAO)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One favourable factor for the programme was the "attractiveness" of the problem to the news media. The myiasis caused by NWS is gruesome, and the news media quickly recognized the dire threat of NWS to the wildlife of Africa south of the Sahara. The political situation between Libya and some Western countries also was newsworthy. The technology used, the SIT, is environmentally friendly, and again appealing to the news media. As a result, the NWS problem in Libya and the eradication programme were widely publicized throughout the world. Undoubtedly, this publicity facilitated the acquisition of the funds needed to run the programme.

On a technical level, expertise from 25 years of successful NWS eradication programmes in the Americas was an enormous positive factor. The knowledge was available and it was utilized.

Certainly one of the most, if not the most, crucial factors for the programme's success was the support of the Libyan government. Its financial, human, physical, and political support made possible the effective and efficient management and implementation of the programme.

The FAO was responsible for overall implementation, and it received strong support from a number of other organizations within the UN system. The IAEA was directly involved in planning and also provided essential technical support for the SIT component from the very beginning. The International Fund for Agricultural Development (IFAD) did an excellent job of obtaining financial support from a wide range of donors. In addition, IFAD was an active participant in the early stages of planning the programme. The United Nations Development Program (UNDP), through its local office in Tripoli, backed the programme strongly, providing essential support services, and assisting international staff with local arrangements.

As commendable was the work and professionalism of a number of contractors. MACES reared, sterilized, and packaged the flies in Mexico; German Cargo transported the flies from Mexico to Libya; and the Libyan Aero Club dispersed the sterile flies in Libya. Importantly, individuals from these organizations exhibited an exceptional degree of personal involvement, and this meant they felt a responsibility to succeed. All three organizations did much more than the minimum required of them.

The FAO's planning of such a large, complex, and expensive programme necessarily took time. The programme could not have succeeded if the FAO had rushed ahead before detailed plans were prepared, or before funds were available to continue the eradication programme without interruption, or before the appropriate field staff had been located and equipment and supplies identified. In addition, arrangements to obtain sterile NWS from the MACES mass-rearing plant required action by the US Congress and the Government of Mexico. The fact that the programme was successful demonstrates that the planning and arrangements for materials and personal were done in a manner that was both timely and effective.

The mechanism which FAO established to implement the programme, patterned after the FAO Locust Control Programme, concentrated the decision-making authority within a very small group of people. This effective approach was a major reason behind the NWS eradication programme's success. Additionally, the FAO kept donors and interested parties aware of the progress and problems of the eradication programme through the frequent publication of a newsletter and other information materials.

Before it all began, many scientists and administrators had doubts that the programme to eradicate the NWS from Libya would be successful. Doubts were based on preconceived ideas that a high percentage of technical assistance projects in developing countries fail or are only partially successful, and that Libya is a very difficult place to operate a programme as demanding as NWS eradication.

Fortunately, the preconceptions never materialized. In the final analysis, it is worth asking why the doubters doubted and why they were wrong. ❐

Major donors and supporters

More than 20 countries and regional and international organizations provided funds and other support to the NWS eradication programme in North Africa:

- Australia
- Austria
- Belgium
- Finland
- France
- Germany
- Ireland
- Italy
- Libyan Arab Jamahiriya
- Luxembourg
- Netherlands
- Spain
- Sweden
- United Kingdom
- United States
- African Development Bank
- Commission of the European Communities
- Food and Agriculture Organization
- International Atomic Energy Agency
- International Fund for Agricultural Development
- Islamic Development Bank
- OPEC Fund
- World Wildlife Fund