

Technology Needs for Humanitarian Demining

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Issue 1: February 1st 2000

Aim of the Study

The study was commissioned by the US Army Night Vision and Electronic Sensors Directorate at Fort Belvoir, Virginia USA, to provide a data base of demining technology needs, prioritised where possible, and presented on a country-by country basis.

What are technology needs?

We have worked on the following definition:

A technology needed by deminers is one which would measurably improve either safety, quality or cost-effectiveness without compromising the others if it were available in the form of equipment or other means. This includes technologies which are known, and possibly available for purchase now, and those which need further research and/or development.

Summary of Results

The most urgent technology needs expressed by the demining community are:

- **Mechanisation:** deminers need mine-resistant vegetation cutting machinery, and other multi-purpose machinery which can be adapted for demining and other construction tasks as required. They prefer versatile machines to special purpose machines. Much of this machinery is currently available from commercial suppliers, with some (mostly minor) modifications. Magnets can reduce later work by manual deminers by collecting surface metal fragmentation. Significant cost reductions and production rate improvements are achievable with more mechanisation.
- **Mine detection dog performance indicators:** deminers are concerned that dog performance cannot be relied on, and there is insufficient documented know-how and scientifically sound performance testing. A major international study has been commenced under the leadership of the Geneva International Centre for Humanitarian Demining (GICHD), but more resources are needed.

- Deminers often asked for detectors which can distinguish mines from metal fragments, either sensing explosive or other aspects of mines. The high false alarm rate from metal detectors and probing is a major cost factor.
- Quality control techniques: quality control is a major issue in many demining programs, perhaps causing more arguments than any other issue. The existing quality standard needs to be reviewed and replaced with more practical alternatives. More cost-effective quality control sensing technologies are also needed.
- Better protective equipment is needed. While there are good designs now available, comfortable protection from high velocity fragments is needed in some regions.
- There are many less obvious needs such as high quality drinking water, better uniform materials, better hand tools which are relatively easy to satisfy and could, when combined, lead to significant performance improvements.
- Information technology: deminers need better internet access, better mapping software, and better data collection and distribution between central databases and field offices. Aerial photography could help deminers in several countries, but its potential is only just beginning to be appreciated.
- Vegetation is a major problem in several countries. While machinery can help, in the longer term, the cost of having to clear vegetation with special vehicles before checking for mines is prohibitive. Methods of localising explosive contamination could greatly reduce environmental remediation costs in many countries, particularly the Balkans, Africa, Central and South America, South Asia, and South East Asia. Faster release of uncontaminated land can bring major economic benefits.
- Special operational needs: deminers expressed many special operational needs, such as clearing mine-contaminated rubble from buildings in Afghanistan, clearing mines washed into rivers in floods, deeply buried mines, and mines laid in mud flats or swamps where men and machines cannot get access.

Suggested response

The needs identified by this study could be satisfied by a coordinated response from the donor community. Part of the reason why these needs have not been satisfied already is a lack of understanding of the real problems faced by deminers. Another reason is that aid donors, and in some instances demining program managers, are not fully aware of these needs.

Many of the technology needs can be satisfied with equipment which is available now, often at modest cost. Donor institutions could significantly increase the effectiveness of the resources they provide now by ensuring that these needs are satisfied. These needs include:

- **Mechanisation:** machines and appropriately equipped support organisations could significantly improve the cost effectiveness of several demining operations in a short time.
- **More mine detection dogs are needed:** properly used, dogs could improve the effectiveness of several mine clearance programs.
- **Better protective equipment is needed:** commercially available equipment could significantly reduce injuries to deminers.
- **High quality hand tools, high quality drinking water supplies, and more attention to details such as uniform materials to improve deminer comfort** could yield significant performance improvements at modest cost. Given that each deminer costs about US\$10,000 a year to support in the field (salary, equipment, supervision, training, logistics etc.) in the third world, and up to US\$50,000 or more in Europe, a 10% performance improvement could save about US\$1,000 annually for each deminer.
- **Information technology improvements could also bring significant cost savings through better resource allocation.**

Other technology needs require further research and development. The US sponsored 2010 initiative aims to mobilise about US\$1,000,000,000 yearly for landmine eradication. The research and development needed to satisfy most of the outstanding needs of deminers could be completed with approximately US\$30,000,000 yearly. However, most of the current research funding (perhaps US\$300,000,000 annually) is not being used in the most effective manner to solve demining problems.

The major part of the research effort is directed at high technology detectors, both vehicle mounted and man-portable. This research aims to satisfy the need for a detector which can distinguish mines from the metal fragments which confuse current metal detectors. However, this effort started in the early 1990's and has not yet yielded any useful improvements.

A relatively small research budget, better directed, could make much more impact if it pursues the following objectives:

- Find ways of measuring and predicting the performance of mine detection dogs.
- Develop effective quality measurement and assurance methods.
- Find ways to survey and map mine and UXO contamination in large areas of terrain without the need for men or machines to enter the affected land. Promising methods include extending current air sampling methods where dogs sniff the samples, and the use of bacteria to indicate localised explosive traces in the environment. Aerial photography also shows some promise where vegetation is thin enough.
- Resolve special operational needs such as clearance measures for mud flats, rivers and sandy areas, residential areas in Afghanistan etc.

- Refocus research of detection technology at the problem of *reducing* the false alarm rate rather than *eliminating* false alarms.

If successful, these efforts would provide huge improvements in cost-effectiveness in mine and UXO clearance.

Obtaining the information

The study was conducted by arranging country visits when possible by at least one team member. During each visit, team members discussed as many aspects of mine clearance as possible in the time available, and visited minefields, mined areas and other parts of the country. A detailed report on each country describes these activities and what was learned.

In order to collect information systematically, team members followed an interview guide which was designed as a 'survey instrument' using techniques evolved by the social sciences. Since the aim of the study was to determine needs, many of which were not definable when the study started, the aim of the survey instrument was to allow interviewees to discuss the problems and challenges they encounter in demining with as little prompting as possible. The issues they raised were noted and explored further if necessary. This type of approach is now a well-established method for this type of study. Naturally, some issues required more specific, quantitative data to be completely understood. Once issues had been defined, it was usually easy to collect the data needed.

A copy of the survey instrument is included in appendix 1.

The success of this technique is amply demonstrated by several completely new concepts which arose from the study. These concepts were not part of the demining 'state of the art' when the study commenced.

Whenever it was feasible, the country reports were sent (in draft form) to relevant authorities to confirm their accuracy. Also, we had opportunities to discuss the draft report with several country representatives at a meeting of demining technology experts in Geneva in December. Several minor changes were made, and information on other countries (Chad and Nicaragua) was added.

In some instances, information was obtained from other experts who were familiar with countries we could not visit. These experts included:

Mr. Bill van Ree, Mine Action Consultant, former manager of Mine Action Program for Afghanistan, currently restructuring Cambodian Mine Action Centre.

Maj. Colin King, Mine and Explosive Ordnance Disposal expert and editor of Janes 'Mines and Mine Clearance'.

Mr. David Edwards, former Program Manager, UN Mine Action Program for Northern Iraq.

Each was interviewed using the survey instrument as a guide.

All the detailed information in the country reports will be added to the web site once the relevant country authorities have confirmed the validity of the information.

Guide to the tables

All the needs which were discussed, or which arose as a result of this survey are defined in the sections which follow. These definitions serve as a reference for the tables which follow.

There are two tables:

- 1) A summary table which lists the needs and the potential utility for each country.
- 2) A detailed table for each country which repeats the summary information, but also shows:
 - a) Who raised the issue: UWA interviewer(s), staff managing the mine action program in the country (often ex-patriates), or deminers. The term 'deminers' refers both to the deminers who do the mine clearance work, and managers or supervisors who are directly responsible for the deminers. As there was never enough time to explore all the issues, many entries in the table are shown as 'not discussed'. In a few instances it was possible for us to suggest the potential utility of needs which were not discussed.
 - b) Some comments on the availability of a solution. In many instances, further research and/or development is needed. However, many of the technology needs mentioned are readily available from commercial or government sources. In these instances, the solutions are not available (at the desired levels) either because of funding shortages, or because the staff are not aware of the availability, or the staff only appreciated the specific need and solution as a result of our approaches and interviews.
 - c) Some additional comments are also provided in many instances to add further detail or qualifications.

In several instances, staff and deminers expressed different opinions. Sometimes the opinions were strongly expressed and there were serious disagreements evident within each country. For example, there are many different views on the utility of dogs, MEDDS systems and ground milling machinery.

Technology Needs - Descriptions

The technology needs have been classified into the following categories:

- a) Detectors and Detection Techniques
- b) Mechanical assistance for deminers
- c) Personal equipment and tools
- d) Measurement needs

- e) Information and Information technology
- f) Other unclassified operational needs

After the description of each requirement there are some brief comments on availability and research or development needed.

Detectors

Mine Detecting Dogs

Requirement: Mine detecting dogs for locating suspected mines in suitable areas.

Availability: Training and handling techniques are well known but only in certain countries. Problems have been encountered in some countries with disease and uncertain results.

Sniffer detector

Requirement: An explosive “sniffing” sensor or detector with equal or better sensitivity than a mine dog. (This would also detect explosive fragments remaining in soil, of course). It is assumed that the device is portable and meant to be used like a metal detector, though other configurations might also be useful (e.g. vehicle mounted).

This technology has been classified separately from other technologies (such as metal detection) because, as we know from work with dogs, a vapour detector will not be able to localise a target accurately. Experience suggests that vapour can be detected up to several metres from a target, and the strongest indication may be a metre or more away from the explosive location.

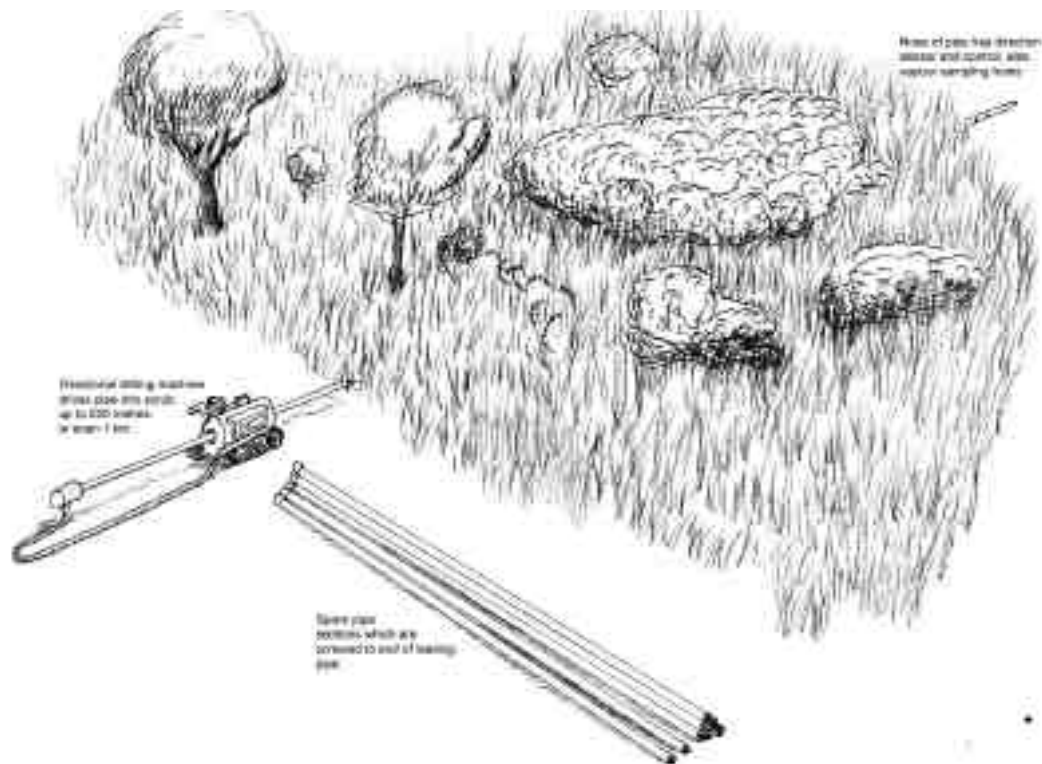
Availability: Extensive research is proceeding, and there has been progress, but the goal is still some years away. The best sensitivity achieved is believed to be about 1% that of a trained dog.

Scrub sniffer

Requirement: An explosive sensor (or sniffer) which does not require scrub or vegetation clearance before use. This could take the form of rigid tubing, in sections, which can be inserted into moderate or heavy vegetation, up to a distance of 200 metres or more, perhaps up to 1 kilometre.



There are two houses in this photograph which graphically illustrates vegetation problems in the former Yugoslav republics. At the moment, the vegetation has to be cleared before detectors or dogs can be used. This shows why a 'scrub sniffer' could be so useful.



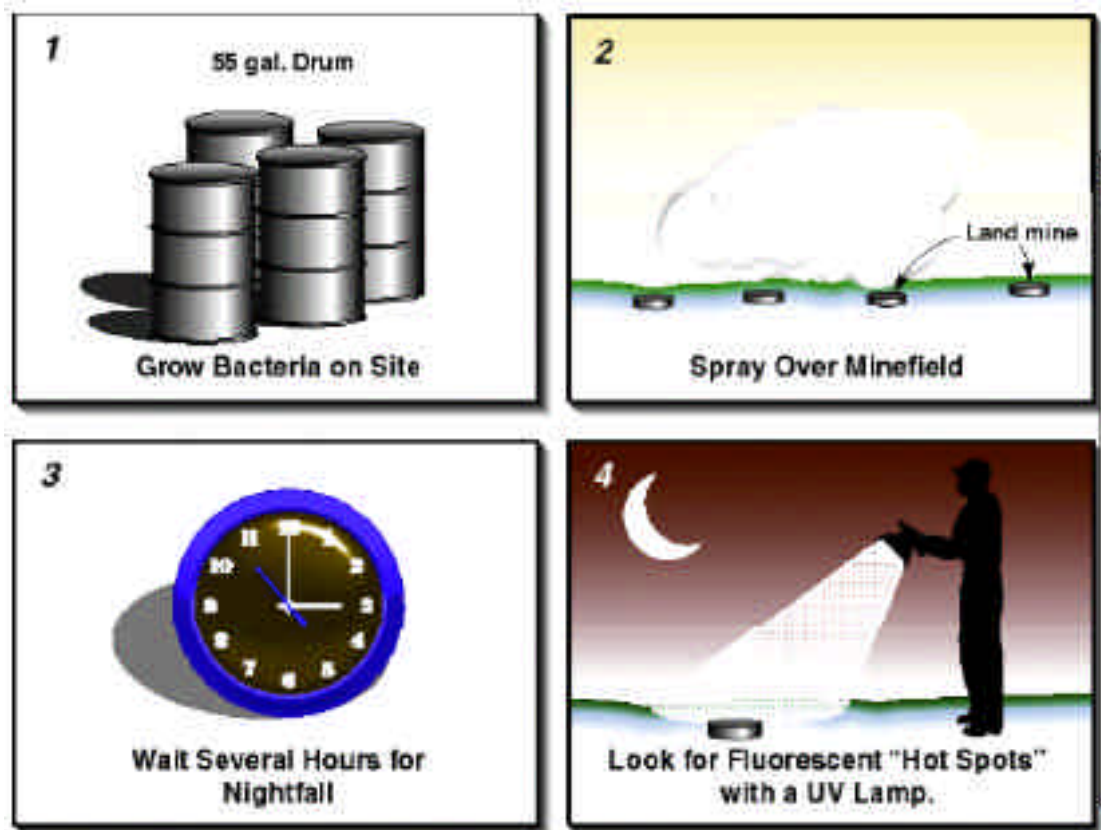
Scrub Sniffer concept. A small machine propels pipes into scrub. Air is drawn through holes near the tip, and passes through a vapour detector or MEDDS filter. Direction drilling technology can be used to steer the pipe at least 200 metres and possibly up to 1 kilometre.

Availability: Like the sniffer detector, this development is dependent on sensor technology which is not yet available. However, it is possible that the MEDDS technology could be adapted. Air drawn from the leading end of the tube, or from

separate holes along the pipeline, can be passed through a MEDDS filter which is then checked by dogs.

Equipment to insert the tubing and maintain a constant direction of travel is well developed. Horizontal underground directional drilling equipment has the required capabilities and is now inexpensive. While not being used for demining it can be used for infrastructure development.

An alternative concept has emerged from research at Oak Ridge National Laboratory. Common soil bacteria are modified by standard genetic engineering techniques so that they ingest TNT in the environment and fluoresce when illuminated with ultra-violet radiation of a particular wavelength. Early trials have shown promising results. One unexpected outcome is that the bacteria seem to thrive also on plant leaves. Thus, the soil does not have to be visible to the overhead scanner: bacteria on leaves also pick up the TNT and reveal explosive traces. There is still considerable development required for this concept.



Concept for using genetically engineered bacteria for indicating the presence of explosive (TNT) traces developed at Oak Ridge National Laboratory

QA detector

Requirement: A device which can be left in cleared area that will detect presence (or absence) of explosive in approx. 500 sq. m area in about 10 to 15 days. Quality assurance is a major issue in demining operations. Current techniques often rely entirely on repeating a proportion of the demining work using the same method as the

deminers used themselves. In many operations, QA is performed by deminers playing football and other games on the cleared area.

Availability: Like other sniffer detectors, this requires research and development, but if combined with MEDDS technology this could be relatively quickly developed.

Mineralised soil metal detector

Requirement: Mineralised soil interferes with normal metal detectors making them useless in specific areas or entire regions. Metal detectors which can work in these conditions are needed.

Availability: Several metal detector manufacturers now provide equipment which works in mineralised soil (eg Minelab in Australia). The extent of mineralisation in which the detector will work depends on the specific model.

Availability: UXO and targets with significant iron content can be located at depths of up to 10 metres with magnetometer technology. Depending on the sensitivity, this can be expensive. The best technology, with reliable detection at 10 metres, costs about \$1500 per day, or about \$1 per square metre.

Detecting small metal content devices at greater depths is possible with metal detectors fitted with large coils: the detection depth is roughly proportional to the coil size. However, the location precision also decreases proportionally, and the ability to distinguish between multiple targets (or mines with fragments) decreases. Large coils may be inconvenient to use.

Low false alarm rate mine detector

Requirement: Improved mine or metal detector with low false alarm rate: it can ignore small pieces of shell fragments etc. This is the goal of several quasi-military research projects using combinations of metal detectors, ground penetrating radar, infra-red and other sensor technologies. It is assumed that the device is meant to be used like a normal metal detector.

This need is probably the most often expressed need by deminers. I have classified this need separately from 'sniffer' detectors largely because the technology and method of application is entirely different.

Availability: Despite extensive research on component technologies in USA, Britain, Germany, Italy, Japan and many other countries, the goal remains elusive. The principal difficulty is a false negative problem: given a target which has a metal signature, other forms of sensing must reliably classify the target as either a mine or junk. The probability of a false negative (i.e. classifying a mine as junk) must be extremely low. There is also a potential cost problem if a suitable technical solution can be demonstrated. The reason why such intense efforts have been devoted to this problem is the requirement from defence forces.

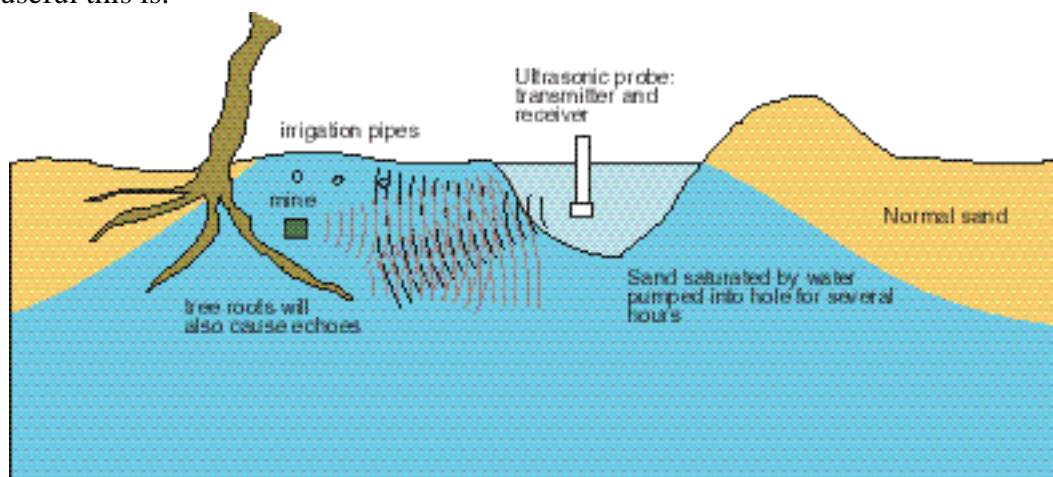
Deep target mine detector

Requirement: This is needed where erosion products have buried mines (due to flood, storm or wind effects). Mines can be found up to 2 metres underground in several countries, and deeper in special situations.

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In certain conditions (such as sandy soils or mud), ultrasound may be a feasible means for detection and location of mines. The number of false alarms will determine how useful this is.



Drawing: One possible scheme for using ultrasonic technology for locating deeply buried mines in sand. This may be appropriate in Jordan and possibly Egypt. R&D is needed to determine the limits of this approach.

Detector for mines in mud

Requirement: In several countries, mines are thought to be distributed in or under mud and sand along river banks, in salt lakes and marshes. While some metal detectors will work in salt water, the depth of mines under mud and the presence of water suggests that other detection technologies may be useful, such as ultrasound.

Availability: Several research projects are working on this problem for detecting sea mines lying below the sea bed. The mineral exploration industry uses ultrasound techniques. Medical imaging technology may be useful as well. However, no devices are thought to be available specifically for mine clearance tasks. UXO's can be detected with conventional magnetometers, but access to these areas is always a problem.

Trip wire detector

Requirement: A detector which can locate trip wires. One feasible configuration of a trip wire detector consists of a cord or rope with sensor on the end. The sensor can be thrown out up to 20 metres and pulled back to operator. Sensor detects any metal trip wire it passes over – up to 5cm above trip wire it will still indicate. The sensor will not be sensitive to small fragments. The sensor may or may not be able to detect non-metallic tripwires.

Availability: This type of detector is technically feasible, but few deminers have expressed the need for it.

Mechanical assistance for deminers

Ground preparation - vegetation cutter (Flails)

Requirement: Ground preparation machine strictly for vegetation cutting only. The ground conditions and other requirements (slope width, cutting capacity) needs to be specified. A range of different machines may be required.

Availability: For level or gently sloping ground there are several machines with a record of success. For steep terrain there are no machines currently available. However, there are forestry machines which can work on steep slopes and it should be possible to adapt one of these if the need is sufficient.

Ground preparation machine (e.g. Flails, Minebreaker, Rhino).

Requirement: This kind of machine uses strong rotors to churn the ground and break up mines, tree roots, stones etc. into small pieces, destroying mines.

Availability: Several machines have been demonstrated, but none have demonstrated 100% reliability. Many deminers express strong reservations for this technology:

- Damaged mines are more difficult to render safe than undamaged ones,
- By breaking metal and mines into pieces, a larger number of targets need to be checked after using the machine, and they will be pushed to depths of up to half a metre or more, and,
- The presence of large UXO's prevents these machines from being used.



Rhino machine for ground preparation. The ground milling roller at the front breaks all objects encountered. However, tests have shown that not all mines are destroyed by machines like this.



Photograph: Aadvark flail machine. Several flail machines are being used for vegetation clearance in support of manual deminers rather than their original intended role of mine destruction.

Backhoe excavators, front-end loaders, possibly armoured.



Photograph: Armoured back hoe used in Kandahar, Afghanistan

Requirement: A machine which can excavate material which potentially contains AP mines and/or smaller UXO, which is armoured against the effects of mine explosions.

Availability: Deminers in Afghanistan use small armoured backhoes for processing rubble from destroyed buildings which may contain AP mines and/or UXO. They are also used for digging material from irrigation canals which contain mines. Some military forces have comparable machines in their fleets. The economic advantages have been demonstrated and many deminers have expressed the desire to have them.

Rubble crusher

Requirement: A rock crusher to process rubble from buildings, possibly containing AP mines and UXO. It has a magnetic separator to remove UXO and some mines before they enter the crusher. The crusher can withstand an AP mine, that cannot be magnetically separated, exploding inside.

Availability: An experimental device is being evaluated by HALO trust in Kabul.

Magnetic fragment removal

Requirement: In some regions large numbers of fragments, mostly magnetic, lie on the surface or near the surface making work with metal detectors slow or impossible. Magnets mounted on suitable machinery can remove fragments. Even if 100% removal is not achieved, every fragment removed means less work for a deminer.

Availability: Research has demonstrated that this technique can be effective. Magnets can easily be fitted to other machinery used in demining operations.



Photograph: Tests with permanent magnets fitted to a backhoe showed a surprising ability to remove fragments from the ground.

Personal equipment for deminers

Water filtration equipment

Requirement: In some countries, deminers have difficulties obtaining clean water for drinking. This is a particular problem in hot climates. With muddy water, even though it has been boiled, deminers are not confident and suffer from dehydration as a result, and work less.

Availability: Water filtration equipment to provide adequate supplies of clean and safe drinking water is readily available commercially.

Saws and vegetation cutting tools

Requirement: Deminers are often issued with poor quality saws and vegetation cutting tools in the belief that this saves money. When shown high quality tools, deminers have shown how improved performance will save more than the cost of the tools.



Photograph: ARS Type of folding saw.

Availability: Commercially available, particularly from Sweden and Japan where governments donate generously to demining programs.

Cotton uniforms

Requirement: Deminers in some countries are issued with synthetic uniforms which are extremely uncomfortable in hot weather conditions, again in order (apparently) to save money. Deminers have to endure discomfort and therefore work slower, wasting money.

Availability: Appropriate fabrics are readily available. Countries such as Pakistan and Bangladesh can manufacture appropriate clothing at low cost if local capacity is insufficient.

Protection from non-explosion hazards

Requirement: Deminers in several countries face many hazards from non-explosive devices. These include thorns, ants, snakes, mosquitoes, grass (cutting skin of hands), sharp fragments in ground (apart from other hazards such as sickness, road accidents etc). Loss of time due to these causes can be avoided with standard precautions using low cost commercial products.

Availability: Protection is feasible using normal commercial products. Protection from snakes can be provided by some animals.

Low insertion force probe

Requirement: This would extend the distance and depth for probing which can be useful in soft ground for investigating targets. Current probing methods only penetrate about 10 cm below the surface.

Availability: Research has demonstrated several improvements to probe designs, and some motorised designs. However, demining organisations seem unaware of the possibility of improvements.

Magnetic probe

Requirement: A magnetic probe to help find small magnetic fragments in loose earth, reducing the time needed for investigating targets, especially when deminers are required to remove all metal for quality control checks.

Availability: Several devices have been demonstrated. Cambodian deminers carry small magnets with them.

Smart probe

Requirement: A probe that provides information on the material contacted by the probe under the ground to distinguish between stone, wood, plastic, metal etc.

Availability: Defence researchers in Canada have developed a prototype device. Some deminers claim they can do this without additional instrumentation.

Excavation tools

Requirement: Special purpose tools for excavating suspected mines in different situations such as hard ground, deep holes etc.

Availability: A wide range of tools has been developed and demonstrated. Most can easily be manufactured in low-technology workshops.

Ground and rubble breaker

Requirement: Hand tools for breaking compacted rubble inside buildings. These must be remotely operable in cases where explosion risk is present. (see also under operational needs)

Availability: Research is proceeding on tools for Afghan deminers. No devices are commercially available.

Ground marking equipment

Requirement: Mounted on a detector, a ground marker can save time and improve location accuracy, potentially reducing the incidence of missed mines and accidents.

Availability: Several types have been demonstrated, but none are thought to be in use.

Improved personal protective equipment

Requirement: Comfortable protection from blast mines is feasible. Comfortable protection from larger fragmentation mines is an important requirement in several regions.

Availability: Although almost complete protection is technically and commercially feasible, most deminers working with blast mines only have head and face protection. Hand injuries (from prodding accidents) can easily be reduced by prodders with blast shields.

Current technology provides limited fragment protection for the head and torso, but none for limbs and little for the face. Discomfort is a problem: deminers tend not to wear protective equipment in hot conditions without tight supervision.

Genital armour has been requested by some deminers.

Mine-resistant boots

Requirement: These boots (or over-shoes) either reduce or eliminate blast mine injuries. Deminers would like mine-resistant boots for emergency use when, for example, a deminer needs rescuing after an accident or when he walks into an uncleared area. They are not needed or wanted for routine demining. If deminers miss mines they are not working properly.

Availability: Several types are manufactured, but there are different views on their usefulness and efficacy. Some demining groups have them as standard equipment, but they seem to be rarely used in practice.

Scratch -resistant film for visors

Requirement: Blast-resistant visors made from polycarbonate materials scratch easily. Scratch resistant films extend the life of the visor and improve vision. This reduces the likelihood that a deminer will take off (or raise) his visor to see better.

Availability: Commercially available products are easy to apply and replace when needed.

Anti-fog treatment for visors

Requirement: A simple treatment to prevent condensation from a deminer's humid breath from obscuring vision. This problem reduces the effective working time in cold weather.

Availability: Several treatments are readily available. In cold weather, this raises efficiency, and reduces the chances that a deminer will raise his visor or not use it when an accident occurs.

Universal battery charger

Requirement: A universal adaptive battery charger would help in many demining operations. This would operate from vehicle battery outlets, local power, or solar cells.

Availability: No commercial product seems to meet the requirement currently. Most products using rechargeable batteries provide their own non-standard recharger.

UXO cutter

Requirement: A low cost, portable device which can cut a 25 mm diameter hole in a typically 12 mm thick steel casing of a bomb or shell. With one or two holes cut, the explosive can be burnt out safely. This is needed where shells or bombs are found too close to other 'assets' to be destroyed by explosives. Shaped charge explosives can usually destroy a device without a full strength, high order detonation, but the risk is often too high in civilian-occupied areas. Thermite 'burners' also have explosion risks.

Availability: The current technology is a 'Trepana' which is a specially adapted circular hole saw which comes with its own mountings, power pack and other equipment in a standard trailer configuration. However, in remote areas (e.g. Laos) this equipment is either too expensive or not portable up steep jungle paths. Water jet cutting systems are more expensive still and less portable.

UXO spinner

Requirement: A low cost, portable high-torque device which can remotely unscrew a fuse from a large UXO.

Availability: Military solutions are available, but the cost and weight are too high for remote areas in developing countries.

Information and Information Technology Needs

High quality internet access.

Requirement: Typically a field office far a MAC, even a main office, needs 3-4 minutes to download a single page. This means the internet is of limited use for field staff. E-mail can work OK, but web access to search for information requires 3 to 4 bytes per second download speeds.

Availability: Commercially available at reasonable cost.

Field data recording

Requirement: Portable computer-based field data recording equipment which can be used to record details of areas cleared, material moved, working time, mines and fragments located, and all other data normally collected during mine clearance. This equipment would reduce the possibility of data entry errors, and expedite data collection for resource management.

Availability: There are many commercial products (e.g. palm computers) which could be adapted for this, but software is needed.

Data distribution and updating

Requirement: Means of distributing database and updates automatically, and in a timely manner to field offices, and also better methods for collecting data from field offices.

Availability: Commercial solutions exist but need to be adapted for demining databases and GIS systems.

Map and photograph registration

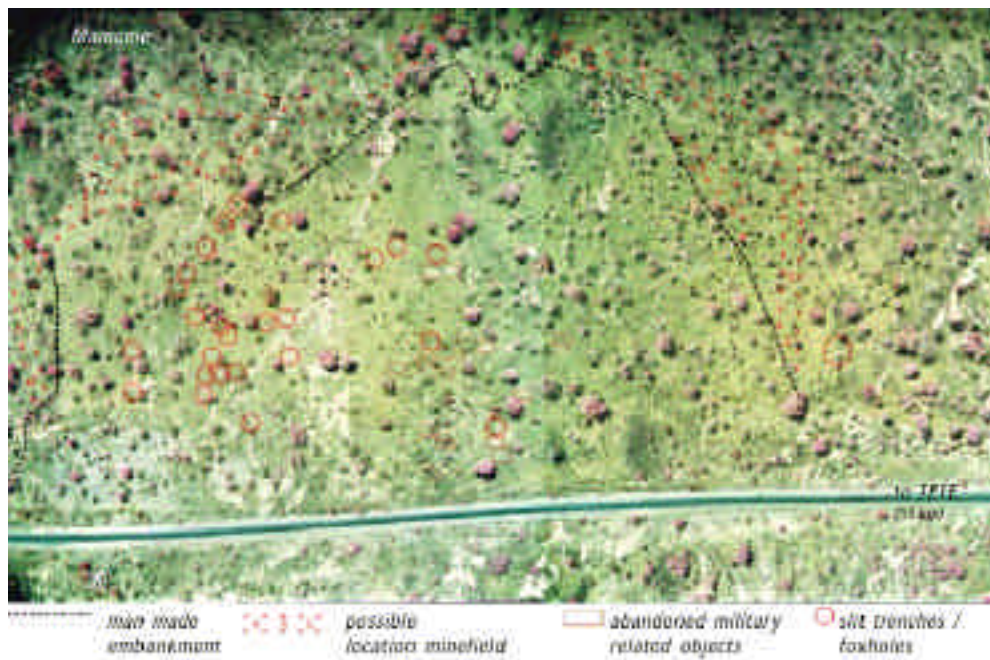
Requirement: A geographic information system (GIS) which can register maps with different grid systems (e.g. UTM, lat/long, Gauss Krieger etc.) and digitized aerial (or satellite) photographs. Large scale maps of a region are difficult to obtain to help with demining operations. For example, for Bosnia, some excellent maps were obtained (surreptitiously) from the Ministry of Defence in Belgrade just before NATO bombs destroyed the building. These use Gauss Krieger projection but the GIS is programmed for UTM grid. Similar problems occur when trying to register aerial photographs with maps. The Croatia GIS displays several Croatian minefields beyond Croatian borders for the same reason.

Availability: Techniques for achieving this are well known, but not yet available in GIS packages used by deminers.

High resolution aerial photography

Requirement: High resolution aerial photos of work site that can be viewed in stereo, with resolution of 2mm, (i.e. can see trip wires if visible from above). These have been shown to be useful in Mozambique.

Availability: Cameras and film are relatively easily available either through defence establishments or commercial survey firms. The cost is claimed to be about US\$10,000 per square kilometre (Reference: <http://www.itc.nl/ags/research/posters/main.htm>).



Example of aerial photographs used for topographic interpretation of potentially mined area in Mozambique. Subsequent technical survey confirmed the interpretation. (Photo: ITC).

UXO render-safe procedures

Requirement: Deminers need access to procedures for safe handling of UXO.

Availability: Information on render-safe procedures for Russian, Chinese and other ammunition seems to be readily available to deminers. Information on US, Israeli, and some European ammunition is classified and not available. Apparently US information is only released when all 'allies' no longer wish to retain a given type of ammunition in their stores. There is a pressing need for deminers to acquire these procedures, or for the US and other countries to supply trained personnel to do this.

Socio-economic survey / analysis

Requirement: Mine action managers need decision-making tools to help allocate resources. They also need to help donors to evaluate needs for assistance and to demonstrate effectiveness of mine action programs.

Availability: No satisfactory methodology seems to have been developed and tested.

Measurement Needs

Dog performance tests

Requirement: A scientific understanding or measurement method which would identify the likely effectiveness of dogs in a given situation. Tests have shown dogs to be less effective in some conditions, possibly completely ineffective on occasions. However, no one in the field seems to be able to predict this measure this, or explain it.

Availability: Research has been carried out on explosive vapour and soil interactions, explosive vapour and water interactions, and explosive vapour diffusion. However, no convenient solution is available for deminers. Further research is needed.

MEDDS Improvement

Requirement: The MEDDS system being used in Angola needs some research and improvement. The parameters of the system being used are thought to be non-optimal and no definitive data is available to determine this.

Availability: Field-based research is needed.

Quality performance measurement

Requirement: A replacement is needed for the current 99.6% clearance specification. A replacement 'standard' must be soundly based on engineering principles and be conveniently specified and monitored in the execution of a demining contract. The current requirement cannot be verified without knowing how many mines are buried and only then if a large number of mines are present.

Availability: Research and field testing is needed. There are several feasible ways to achieve this, one of which involves placing known targets into a minefield before clearance: the targets are designed to be harder to find than the mines. The number of targets subsequently found by the deminers indicates the quality of their work.

Productivity performance measurement

Requirement: A means of monitoring the progress of demining work to ensure that demining teams work at a speed appropriate for the terrain. Working too fast is thought to decrease the reliability of clearance.

Availability: While performance information is available, it is not easy to relate clearance performance to the resources employed. For example, cost information from Bosnia does not distinguish 'donated' equipment costs from 'leased' equipment costs.

Resolving the quality measurement problem would, to some extent, reduce the need for this. Efficient companies do this in any case: the difficulty is comparing data from different organisations.

Operational needs not classified

Deep mine location and excavation

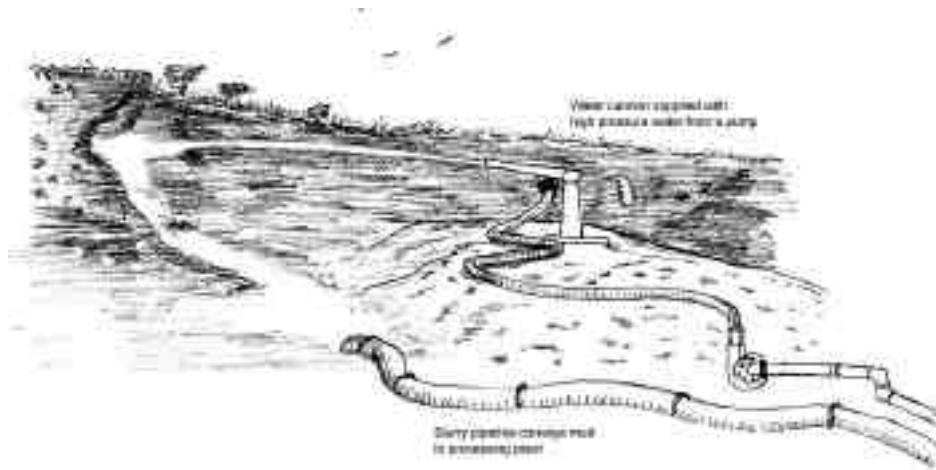
Requirement: Mines are often located deep beneath the surface (see deep mine detector requirement above). If detection technology is not likely to be available, alternative techniques are needed to locate and remove mines, or neutralise them.

Mines located below wet or muddy terrain pose different problems - see separate heading below.

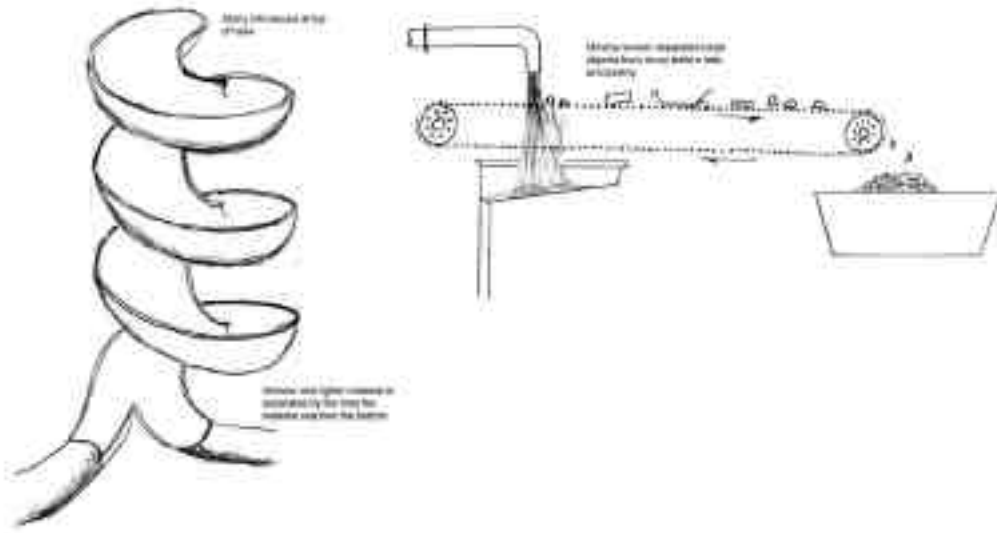
Availability: There are no easy solutions at the present time. Mining technology provides many potentially useful methods. Research on soil sucker and other water jet devices may also provide useful solutions. In cases where wind-blown sand causes the problem, the wind may be harnessed to expose the mines it has buried in the past. Similarly, water could be used to reveal the mines which have been buried in floods.

The cost is about US\$0-20 per tonne of material removed, and practical expertise exists in several countries, particularly Malaysia and Indonesia.

Research is required.



Drawing: Water jets are used for sand mining. This method keeps machines well away and may be more cost effective than manual digging for recovering deeply buried mines.



Drawing: Many technologies are available for separating components of slurry: the drawing shows a helical vortex separator and moving screen.

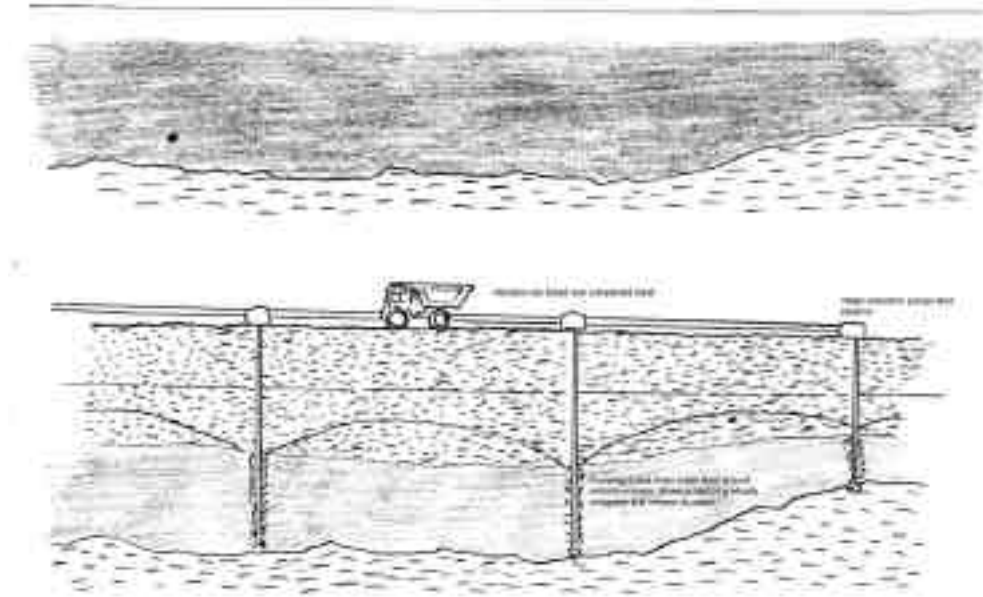
Mud flats

Requirement: Mines located in muddy areas (possibly salt marshes and lakes or in river beds, river banks) pose significant problems. Methods for dealing with these mines (an UXO with them) are needed in several countries.

Detection problems have already been referred to above (see detector for mines in mud).

Availability: No effective solutions exist. Mining technologies offer many possible solutions which need to be explored. Among these are:

- Liquefying the mud with water jets or vibration and pumping the resulting slurry through separation machinery which removes mines and other material, and then returning the mud to its original or a new location.
- Depositing dredged sand or mud over the existing material to bury the mines or UXO, and stabilising the material to prevent future erosion and removal of the material. This has to be coupled with strict regulation to prevent future land users from excavating too deeply.
- Exploiting regular water movements (tide or seasonal floods) to remove material and deposit mines and other objects at known predictable sites.



Drawing: Dredging technology: compressing mud for construction purposes. In the top drawing we see water lying over mud which rests on solid strata. The in the bottom drawing we see several metres of sand which has been pumped over the mud by a sand dredge (using water to transport the sand through a pipeline). Later, the surface is firm enough for trucks to continue the process more cheaply. Pumps are used to extract water from the layers of mud. After about 1 - 2 years, the mud becomes a solid strata underlying the sand.

This technique may be satisfactory for simply burying mines and UXO lost in mud or swamps.

Removing compacted mine and UXO contaminated rubble

Principally in Afghanistan, mud-walled houses collapse during years of fighting. Fighters lay mines in the ruins to deter others from using the area for cover, and mines are re-laid when further collapse buries mines making them ineffective.



Photo: Deminer removing compacted rubble in Kandahar, Afghanistan

Removing the mines requires pains-taking excavation of rubble, piece by piece. Rain has compacted the material into a tightly bound mass of clay and rubble.

Social factors and the need to recover building materials prevent wholesale demolition as a means of dealing with the problem.

Mine Resistant Vehicles

Even with solutions to all the problems listed here, many square kilometres of contaminated (or suspected) land will remain uncleared for a long time. One way of reclaiming this land is to provide access with mine-resistant vehicles.

Availability: Long experience from South Africa has shown that vehicle damage and injuries to occupants can be greatly reduced by carefully designed (and tested) vehicle protection. The cost of appropriate vehicles and the risk of injuries needs to be balanced and the benefits from using the land need to be balanced against the cost of mine clearance. Leaving the land unused for a long period may greatly reduce its value for agriculture or forestry later.



Mine resistant vehicle Casspir developed in South Africa

In countries such as Bosnia and Croatia, it may never be economically feasible to clear mines using any foreseeable demining techniques. Encouraging local capacity for mine-resistant vehicles which will allow land to be used may be a much more cost-effective solution. This technology could then, perhaps, be exported to many other mine-affected countries.

Triple Canopy Jungle

In some countries (such as the border between Ecuador and Peru, Nicaragua) minefields were laid in both flat and hilly terrain which has since become covered by thick “triple canopy” jungle. To some extent, there are similar vegetation problems in Croatia, Bosnia and in the demilitarized zone of Korea. Another area of similar difficulty is the border area between Laos, Cambodia and Vietnam. Mines and UXO need to be cleared from these areas.

Availability: Solutions to these problems are yet to be found.

Needs Summary by Country

Country or Region of Need	Central & South America: Nicaragua, Ecuador, Peru									
	Afghanistan	Angola	Bosnia and Herzegovina	Cambodia	Chad	Croatia	Egypt	Jordan	Lebanon	
Detectors (see separate document for details)										
Mine detection dogs	extensive usage now	high	high and controversial	high	limited	v.high	v.high	v.high	v.high	v.high
Sniffer detector	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high
Scrub sniffer	moderate	v.high	v.high	v.high	v.high	v.high	v.high	none	high	high
QA detector	v.high	v.high	v.high	v.high	limited	v.high	v.high	v.high	v.high	v.high
Mineralised soil metal detector	none		moderate	high			moderate			high
Low false alarm rate mine detector	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high	v.high
Deep target mine detector	v.high		limited	limited	moderate	v.high	limited	v.high	v.high	
Detector for mines in mud	limited		moderate	limited	moderate	moderate	moderate	moderate	moderate	
Trip wire detector			v.high				v.high			
Mechanical assistance for deminers										
Vegetation cutter machines (Flails & others)	high in vegetation	v.high	v.high	v.high	limited because of hilly terrain		v.high			low
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	limited	controversial	controversial	v.high	limited because of hilly terrain	v.high (sifting sand)	v.high	limited because of deep mines and UXO	being used now	risk reduction strategies possible
Backhoe excavators, front-end loaders, possibly armoured.	high		moderate	limited		limited	moderate	limited	very useful	unknown
Rubble crusher	limited		moderate				moderate		none	
Magnetic fragment removal	high	moderate-high	moderate	v.high		v.high	moderate	limited	limited	limited
Personal equipment and tools for deminers										
Water filtration equipment				needed						
High quality saws and vegetation cutting tools		needed	needed	needed	v.high		v.high			moderate
Cotton uniforms				needed						
Protection from non-explosion hazards	yes		limited	needed		yes	moderate	yes	yes	yes
Magnetic probe	possibly useful		limited	useful		possibly useful	limited	possibly useful	possibly useful	possibly useful
Low insertion force probe	limited		needed	useful			unknown			
Smart probe	none		unknown	unknown			unknown			
Excavation tools	moderate		very useful	needed		very useful	very useful	very useful	very useful	very useful
Ground and rubble breaker	v.high									
Ground marking equipment	potentially useful			limited		potentially useful		potentially useful	potentially useful	potentially useful
Improved personal protective equipment	needed		needed (frag prot'n)	needed	needed	needed	needed (frag prot'n)	needed	needed (frag prot'n)	needed
Mine-resistant boots	limited		limited	needed			moderate	needed	needed	needed
Scratch-resistant film for visors	very useful	very useful	very useful	very useful		very useful	limited	very useful	very useful	very useful
Anti-fog treatment for visors	very useful		very useful	not needed?		not needed?	very useful	not needed?	not needed?	very useful
Universal battery charger	none			needed						
UXO cutter				needed						limited
UXO spinner				needed						limited
Information/Info Technology Needs										
High quality internet access.	needed		needed	needed	needed	needed	needed	needed	useful	needed
Field data recording	needed		useful				useful			
Data distribution and updating	needed		needed				needed			
Map and photograph registration			badly needed				badly needed			
High resolution aerial photography	potentially useful	potentially useful	potentially useful	potentially useful		potentially useful	potentially useful	potentially useful	limited use	potentially useful

Needs Summary by Country

Country or Region of Need	Afghanistan	Angola	Bosnia and Herzegovina	Cambodia	Central & South America: Nicaragua, Ecuador, Peru	Chad	Croatia	Egypt	Jordan	Lebanon
UXO render-safe procedures				probably needed						very useful
Socio-economic survey / analysis	high priority		badly needed	needed			badly needed			very useful
Measurement needs	essential where dogs used		essential where dogs used	essential where dogs used	essential where dogs used	essential where dogs used	essential where dogs used	essential if dogs used	essential if dogs used	essential if dogs used
Dog performance tests										
MEDDS Improvement		needed								
Quality performance measurement	needed	needed	needed	needed	needed		needed			
Productivity performance measurement	needed	needed	needed	needed			needed			
Operational needs not classified										
Deep mine location and excavation	v. high		limited		moderate	v. high	limited	v. high	v. high	
Mud flats	limited		moderate		moderate		moderate	v. high	moderate	
Removing compacted mine and UXO contaminated rubble	v. high		moderate				moderate			
Mine Resistant Vehicles for civilian use	tractors needed	very useful	high potential	needed		v. high	high potential	limited		moderate
			some severe vegetation problems	some severe vegetation problems			some severe vegetation problems			
Triple canopy jungle					v.high					
Colour Code	Solutions available and will make a big impact		Solutions badly needed, but more R&D required							

Needs Tables - Country Specific

Country or Region of Need

Afghanistan**Specific Technical Needs for Deminers Detectors**

	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	extensive usage now	staff deminers	local R&D needed	possibly 10% further productivity improvement, concerns about missed mines
Sniffer detector	v.high			possibly 10% productivity improvement
Scrub sniffer	moderate	not discussed		vegetated areas are causing concern, many have been deferred
QA detector	v.high	not discussed	R&D needed	QA currently difficult
Mineralised soil metal detector	none	UWA		no mineralised soil known, brickworks defeat all detectors tested so far
Low false alarm rate mine detector	v. high	deminers	R&D needed	future productivity improvement 30% or more would have to work in collapsed buildings - collapsed material is baked hard mud, stones, fragments, UXO etc.
Deep target mine detector	v. high	deminers	R&D needed	few areas cannot be demined without this capability
Detector for mines in mud	limited	staff	R&D needed	
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	high in vegetation	staff	may be provided by Japan	claim to have invented this concept, but need more up-to-date machines to exploit this
Ground preparation machine (e.g. Flails, Uno).	limited	staff	may be provided by Japan	useful in some areas but verification will be difficult. Mainly for vegetation clearance work
Backhoe excavators, front-end loaders, possibly armoured.	high	staff	Commercial	8 in use now, 4 more on order, more needed
Rubble crusher	limited	staff	HALO Trust	difficult to optimise cost-effectiveness
Magnetic fragment removal	high	staff	R&D needed	Gravel, sandy areas with high fragment density, could be fitted to backhoe or flail
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards	yes possibly useful	deminers	Commercial	snakes and scorpions, dust, problems in mud
Magnetic probe	limited	UWA	R&D needed	to be evaluated
Low insertion force probe		UWA	R&D needed	
Smart probe	none	not discussed	R&D needed	hard or rocky soil means that probing is almost never used
Excavation tools	moderate	UWA	refinements needed	Improved tools could improve productivity slightly, but keep deminers happier and protect hands in prodding accidents
Ground and rubble breaker	v. high	UWA	R&D needed	needed for work in collapsed buildings - collapsed material is baked hard mud, stones, fragments, UXO etc.
Ground marking equipment	potentially useful	UWA	R&D needed	paint marking on sand could save some time, say 2% improvement, but biggest benefit is likely to be in quality of clearance
Improved personal protective equipment	needed	UWA	Commercial	evaluating requirements currently, need reassurance on blast secondary fragmentation and shock wave effects in squatting position
Mine-resistant boots	limited	UWA		staff do not think this is important and could compromise quality standards
Scratch -resistant film for visors	very useful	UWA	Commercial	would extend life of visors
Anti-fog treatment for visors	very useful	deminers	Commercial	extend working times for deminers in wet, cold weather
Universal battery charger	none	UWA		currently use dry cells. No plans to change
UXO cutter		not discussed		
UXO spinner		not discussed		

Needs Tables - Country Specific

Information/Info Technology Needs				
High quality internet access.	needed	staff	cost problem	staff would make effective use of this would improve information accuracy, could make use of this
Field data recording	needed	UWA	R&D needed	no apparent means of utilising this
Data distribution and updating	needed	UWA	R&D needed	
Map and photograph registration		not discussed		
High resolution aerial photography	potentially useful	UWA	Air force(?)	needs evaluation, could identify where mines have been exposed by wind
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis	high priority	staff		have attempted an internal study, need formal methodology
Measurement needs				
Dog performance tests	essential if dogs used	UWA	Afghanistan, N. Iraq	Evaluation of dog potential needed
MEDDS Improvement		not discussed		
Quality performance measurement	needed	staff	R&D needed	Quality a vital issue
Productivity performance measurement	needed	staff	local	Major emphasis on this behind safety
Operational needs not classified				
Deep mine location and excavation	v. high	UWA	R&D needed	needed for work in collapsed buildings - collapsed material is baked hard mud, stones, fragments, UXO etc.
Mud flats	limited	staff	R&D needed	Major problem here
Removing compacted mine and UXO contaminated rubble	v. high			
Mine Resistant Vehicles for civilian use	limited	UWA	R&D needed	Could help with transport problems, tractors in suspect areas. Economic resources to pay cost very limited.
Triple canopy jungle		not applicable		

Country or Region of Need	Angola			
Specific Technical Needs for Deminers	potential utility	who raised this?	availability	potential benefits
Detectors				
Mine detection dogs	high	staff	South Africa	dogs mainly used for MEDDS technique, further productivity gains may be feasible
Sniffer detector	v.high	staff	R&D needed	possibly 30% productivity improvement if reliability can be demonstrated
Scrub sniffer	v.high	UWA	R&D needed	potentially the most effective way to deal with extensive areas of vegetation which may contain mines
QA detector	v.high	UWA	R&D needed	QA currently difficult
Mineralised soil metal detector		not discussed		
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more
Deep target mine detector		not discussed		
Detector for mines in mud		not discussed		
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	v. high	staff	Commercial	Several machines in use - this method being widely adopted. Perhaps 20% further productivity gain possible
Ground preparation machine (e.g. Flails, Minebreaker, Rhino). Backhoe excavators, front-end loaders, possibly armoured. Rubble crusher	controversial	staff not discussed not discussed	Commercial, donor	Staff debate utility of these machines. Some groups make extensive use and claim good results. Others claim the work needed to assure complete mine clearance is too expensive and dangerous.
Magnetic fragment removal	moderate-high	UWA	some R&D needed	Could help reduce effort needed for manual clearance (when fitted to vegetation clearance machinery).
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards		not discussed		
Magnetic probe		not discussed		
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools		not discussed		
Ground and rubble breaker		not discussed		
Ground marking equipment		not discussed		
Improved personal protective equipment		not discussed		
Mine-resistant boots		not discussed		
Scratch -resistant film for visors	very useful	not discussed	3M product	would extend life of visors
Anti-fog treatment for visors		not discussed		
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		
Information/Info Technology Needs				
High quality internet access.		not discussed		
Field data recording		not discussed		
Data distribution and updating		not discussed		
Map and photograph registration		not discussed		
High resolution aerial photography	potentially useful	UWA	Commercial	original area chosen by ITC for concept testing
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis		not discussed		
Measurement needs				
Dog performance tests		not discussed		
MEDDS Improvement	needed	staff	R&D needed	Extensive scope for evaluating MEDDS and making further improvements through locally based research
Quality performance measurement	needed	staff	R&D needed	Major problem for staff, cause of many disputes and arguments, essential for commercial contract work
Productivity performance measurement	needed	staff	R&D needed	Staff find it difficult to compare productivity data from different organisations
Operational needs not classified				
Deep mine location and excavation		not discussed		
Mud flats		not discussed		
Removing compacted mine and UXO contaminated rubble		not discussed		
Mine Resistant Vehicles for civilian use	very useful	not discussed	R&D needed	Could alleviate transportation problems, also food distribution and assist with agriculture
Triple canopy jungle		not discussed		

Country or Region of Need

Bosnia and Herzegovina**Specific Technical Needs for Deminers Detectors**

	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	high and controversial	staff	various (not local)	dogs are being used with machinery to clear vegetation, but there are known performance problems which few people know how to address.
Sniffer detector	v.high	staff	R&D needed	possibly 30% productivity improvement if reliability can be demonstrated - problems with digs may indicate similar difficulties for vapour-based detectors
Scrub sniffer	v.high	UWA	R&D needed	potentially the most effective way to deal with extensive areas of vegetation which may contain mines
QA detector	v.high	UWA	R&D needed	QA currently difficult
Mineralised soil metal detector	moderate	staff	Trials inconclusive	Problem is known to exist, and several detectors are being evaluated by different groups
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more
Deep target mine detector	limited	UWA	R&D needed	Some areas may require this, principally river banks and steep slopes where landslides have buried mines
Detector for mines in mud	moderate	staff	R&D needed	many river-bank areas cannot be demined without this capability
Trip wire detector	v.high	staff	R&D needed	need strongly expressed, as this could help reduce time needed for manual clearance, the problem particularly concerning deminers is PROM bounding fragmentation mines. Some non-metallic tripwires, but most contain metal with plastic coating.
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	v. high	staff	Commercial	Several machines in use - this method being widely adopted. Perhaps 20% further productivity gain possible
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	controversial	staff	Commercial, donor	Staff debate utility of these machines. Some groups make extensive use and claim good results. Others claim the work needed to assure complete mine clearance is too expensive and dangerous.
Backhoe excavators, front-end loaders, possibly armoured.	moderate	UWA	Commercial	Extensive reconstruction work necessary, these machines could reduce time and effort on clearance in ruined residential areas.
Rubble crusher	moderate	UWA	HALO Trust	Power of some fragmentation mines may necessitate heavy armour (PROM-1), little local experience
Magnetic fragment removal	moderate	UWA	some R&D needed	Could help with reconprstruction problems
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		Sticky soil limits ability to pick up fragments, but could help reduce effort needed for manual clearance (when fitted to vegetation clearance machinery).
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards	limited	UWA		few other hazards
Magnetic probe	limited	UWA		sticky soil, also most fragments are left in ground (probing procedures used)
Low insertion force probe	needed	UWA	R&D needed	could reduce manual costs by 10%
Smart probe	unknown	staff	Canadian Defence	test results needed
Excavation tools	very useful	UWA	many designs available	HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant on rocky and stony soil areas in south of country. These areas will be important later, not for the time being
Ground and rubble breaker		not discussed		
Ground marking equipment		not discussed		

Needs Tables - Country Specific

Improved personal protective equipment	needed	staff	R&D needed	light weight, comfortable protection from high velocity fragments needed - existing protection helps but better coverage of legs and arms would help reduce injuries from frag. mine accidents staff think that these give dangerous false sense of security
Mine-resistant boots	limited	staff		would extend life of visors
Scratch -resistant film for visors	very useful	not discussed	3M product	cold, damp conditions frequent
Anti-fog treatment for visors	very useful	not discussed		
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		UXO are very old and/or badly corroded.
Information/Info Technology Needs				
High quality internet access.	needed	staff	cost problem	Staff officers have E-mail access, but web access too slow for many purposes. Well trained staff could make effective use of internet resources.
Field data recording	useful	UWA		would improve data collection
Data distribution and updating	needed	staff		frustrating problem for staff currently
Map and photograph registration	badly needed	staff		major problem with GIS systems
High resolution aerial photography	potentially useful	UWA	Commercial	potentially valuable in south where vegetation problems are much reduced
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis	badly needed	staff	R&D needed	Staff need this to help donors make funds available and evaluate results
Measurement needs				
Dog performance tests	essential if dogs used	staff	local	Evaluation of dog problems needed. Performance tests in Sept-Nov 1999 showed less than 25% of dogs performing to required standard
MEDDS Improvement		not discussed		
Quality performance measurement	needed	staff	R&D needed	Major problem for staff, cause of many disputes and arguments, essential for commercial contract work
Productivity performance measurement	needed	staff	R&D needed	Staff find it difficult to compare productivity data from different organisations
Operational needs not classified				
Deep mine location and excavation	limited	staff	R&D needed	Some problems on river banks and where landslides have occurred
Mud flats	moderate	staff	R&D needed	Problem along river banks (thought to be extensive)
Removing compacted mine and UXO contaminated rubble	moderate	staff		Problem associated with reconstruction work
Mine Resistant Vehicles for civilian use	high potential	UWA	some R&D needed	Could help reclaim suspect and lightly contaminate land for use, also potential export market
Triple canopy jungle	high potential	staff	R&D needed	Some very severe vegetation problems, particularly on hillsides

Needs Tables - Country Specific

Country or Region of Need	Cambodia			
Specific Technical Needs for Deminers Detectors	potential utility	who raised this?	availability	potential benefits
Mine detection dogs Sniffer detector	high v.high	staff staff	Mozambique R&D needed	possibly 15% productivity improvement, limited by vegetation, disease threat. Higher gains possible with mechanical support, but economics may be difficult to sustain possibly 30% productivity improvement Very large areas of vegetation with unknown mine and or UXO contamination - a factor in common with Laos and Vietnam. Ability to survey without cutting vegetation is vital, remote detection preferred
Scrub sniffer	v. high	staff	R&D needed	QA currently difficult, need high tech sensors for quality assurance work
QA detector Mineralised soil metal detector	v.high high	staff staff	R&D needed Commercial	Essential for demining in several large regions
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more, depth detection capability also a requirement A few locations, such as collapsed trenches, require this, but excavation is viable alternative
Deep target mine detector	limited	staff	R&D needed	Access problems, most areas can be accessed in dry season when normal techniques are adequate.
Detector for mines in mud Trip wire detector Mechanical assistance for deminers	limited	staff not discussed	R&D needed	currently being evaluated, economics of large machines may be difficult to sustain. Productivity gains depend on being able to find land areas without AT blast mines or large UXO's.
Ground preparation - vegetation cutter (Flails)	v. high	staff	Evaluation	useful in some areas but verification will be difficult - limited UXO problems in some areas
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	v. high	staff	Evaluation	useful for excavation problems in certain locations
Backhoe excavators, front-end loaders, possibly armoured. Rubble crusher	limited	staff not discussed	none limited R&D needed	Can easily be fitted to any mechanical system to reduce manual follow-up by deminers
Magnetic fragment removal Personal equipment and tools for deminers	v.high			Deminers complained about low quality of drinking water Improving tool quality could improve manual productivity by 5-10%
Water filtration equipment	needed	deminers	Commercial	Improving comfort could lift productivity by 5-10%
Saws and vegetation cutting tools	needed	deminers	Commercial	snakes, insects (repellants without side-effects needed), thorns (high quality safety shields, gloves).
Cotton uniforms	needed	deminers	Commercial	finding fragments in sandy areas, deminers use pocket magnets sometimes
Protection from non-explosion hazards	needed	deminers	Commercial local	Several solutions found from research
Magnetic probe	useful	deminers	capacity local	Testing being done HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant if improved detection not available. Change to SOP's being considered requiring excavation in preference to probing.
Low insertion force probe	useful	not discussed	capacity Canadian Defence	
Smart probe	unknown	not discussed		
Excavation tools Ground and rubble breaker	needed	UWA not discussed	many designs available	considerable time is spent on current marking method (sticks and ropes) - paint marking may be quicker in some areas. However, pace of work is so slow that vegetation growth can hide paint marks quickly.
Ground marking equipment	limited	not discussed	R&D needed local	accident details available to some extent, visors, aprons being introduced
Improved personal protective equipment	needed	staff	capacity	staff want foot protection when entering mined areas for emergency rescue
Mine-resistant boots	needed	staff	France	would extend life of visors
Scratch -resistant film for visors	very useful	not discussed	3M product	warm to hot conditions are normal
Anti-fog treatment for visors	not needed?	not discussed		wanted for radios and possibly detectors
Universal battery charger	needed	deminers	unknown	portable, lightweight and low cost version needed - military equipment not portable enough
UXO cutter	needed	staff	R&D needed	

Needs Tables - Country Specific

UXO spinner Information/Info Technology Needs	needed	staff		needed for large UXO's - military versions not portable enough.
High quality internet access. Field data recording Data distribution and updating Map and photograph registration	needed	staff not discussed not discussed not discussed	cost problem	staff are trained to make effective use of internet no apparent means of utilising this no apparent means of utilising this
High resolution aerial photography	potentially useful probably needed	not discussed	Commercial	needs evaluation, possibly very useful in areas with limited access. Timing needs careful choice. Stereo images can show old trench lines and foxholes giving good data on likely mined areas - remote explosive detection preferred This is a problem in Laos - information on US munitions badly needed
UXO render-safe procedures Socio-economic survey / analysis Measurement needs	needed	staff	R&D needed	Some low quality assessments have been done
Dog performance tests MEDDS Improvement Quality performance measurement Productivity performance measurement Operational needs not classified Deep mine location and excavation Mud flats Removing compacted mine and UXO contaminated rubble	essential if dogs used needed needed	not discussed not discussed staff UWA	Mozambique local	Evaluation of dog potential needed important issue Recognised as problem of growing importance
Mine resistant vehicles	needed some severe vegetation problems	staff	S. Africa	AT and large UXO are recognised as threats to vehicles, restricting application of vegetation clearance machinery. Survey using mine resistant vehicles could help.
Triple canopy jungle		staff		Hilly vegetation covered areas in east of country contaminated with UXO

Country or Region of Need

Central & South America: Nicaragua, Ecuador, Peru

		who raised this?	availability	potential benefits
Specific Technical Needs for Deminers				
Detectors				
Mine detection dogs	limited	staff	USA	Vegetation restricts dogs to QA tasks possibly 30% productivity improvement
Sniffer detector	v.high	staff	R&D needed	
Scrub sniffer	v. high	staff	R&D needed	Almost all mined areas are covered in vegetation, often triple canopy jungle. Ability to localise mine and UXO contamination is essential.
QA detector	limited	staff	R&D needed	
Mineralised soil metal detector		not discussed	Commercial	QA currently difficult, dogs preferred
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more, rubbish from previous occupiers a major problem - aluminium
Deep target mine detector	moderate	staff	R&D needed	River flats, mud banks, mines washed away in floods
Detector for mines in mud	moderate	staff	R&D needed	River flats, mud banks, mines washed away in floods
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	limited	staff	R&D needed	much of terrain is too rugged for existing vehicles, mud makes access difficult
Ground preparation machine (e.g. Flails, Minebreaker, Rhino). Backhoe excavators, front-end loaders, possibly armoured. Rubble crusher	limited	staff	R&D needed	much of terrain is too rugged for existing vehicles, mud makes access difficult
Magnetic fragment removal		not discussed		
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools	v.high	staff	Commercial	Improving tool quality could improve manual productivity by 5-10%
Cotton uniforms		not discussed		
Protection from non-explosion hazards		not discussed		
Magnetic probe		not discussed		
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools		not discussed		
Ground and rubble breaker		not discussed		
Ground marking equipment		not discussed		
Improved personal protective equipment	needed	staff	no local capacity	accident details available to some extent, visors, aprons being introduced
Mine-resistant boots		not discussed		
Scratch -resistant film for visors		not discussed		
Anti-fog treatment for visors		not discussed		
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		

Needs Tables - Country Specific

Information/Info Technology Needs

High quality internet access.	needed	staff	cost problem	staff are trained to make effective use of internet
Field data recording		not discussed		no apparent means of utilising this
Data distribution and updating		not discussed		no apparent means of utilising this
Map and photograph registration		not discussed		
High resolution aerial photography		not discussed		Thick vegetation would limit usefulness
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis		not discussed		
Measurement needs				
Dog performance tests	essential if dogs used	staff	USA	Evaluation of dog potential needed
MEDDS Improvement		not discussed		
Quality performance measurement	needed	staff	R&D needed	QA currently difficult, dogs preferred
Productivity performance measurement		not discussed		
Operational needs not classified				
Deep mine location and excavation	moderate	staff	R&D needed	floods, landslides have buried mines
Mud flats	moderate	staff	R&D needed	floods, landslides have buried mines
Removing compacted mine and UXO contaminated rubble				
Mine Resistant Vehicles		not discussed		
Triple canopy jungle	v.high	staff	R&D needed	large contaminated areas in jungle terrain

Needs Tables - Country Specific

Country or Region of Need	Chad			
Specific Technical Needs for Deminers Detectors	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	v.high	staff	Afghanistan, N. Iraq	possibly 30% productivity improvement
Sniffer detector	v.high	staff	R&D needed	possibly 30% productivity improvement
Scrub sniffer		not discussed		
QA detector	v.high	not discussed	R&D needed	QA currently difficult
Mineralised soil metal detector		not discussed		
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more, PMA-3 mines pose a major threat
Deep target mine detector	v. high	staff	R&D needed	many areas cannot be demined without this capability
Detector for mines in mud	moderate	staff	R&D needed	many areas cannot be demined without this capability
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)		not discussed		
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	v. high	staff	Commercially available	Need machines which can work with deep sand, sifting machines, should avoid detonations
Backhoe excavators, front-end loaders, possibly armoured.	limited	staff	none	Possibly very useful
Rubble crusher		not discussed		
Magnetic fragment removal	v. high		R&D needed	Sandy areas with fragments, small UXO.
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards	yes possibly useful			snakes and scorpions, sunburn, dust, problems in mud
Magnetic probe				finding fragments in sandy areas, non magnetic mines
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools	very useful	staff	many designs available	Productivity improvement could be significant if improved detection not available
Ground and rubble breaker		not discussed		
Ground marking equipment	potentially useful	not discussed	R&D needed	paint marking on sand could save some time, say 2% improvement, but biggest benefit is likely to be in quality of clearance, and improvement in safety
Improved personal protective equipment	needed	staff	not in Chad	accident details needed before specifying details, helmets and visors not being used
Mine-resistant boots		not discussed	France	
Scratch -resistant film for visors	very useful	not discussed	3M product	would extend life of visors
Anti-fog treatment for visors	not needed?	not discussed		warm dry conditions are normal
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		UXO are very old and/or badly corroded.
Information/Info Technology Needs				
High quality internet access.	needed	staff	cost problem	staff officers need better English to make full use of internet resources
Field data recording		not discussed		no apparent means of utilising this
Data distribution and updating		not discussed		no apparent means of utilising this
Map and photograph registration		not discussed		
High resolution aerial photography	potentially useful	staff	?	needs evaluation, could identify where mines have been exposed by wind
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis		not discussed		
Measurement needs				
Dog performance tests	essential if dogs used	staff	Afghanistan, N. Iraq	Evaluation of dog potential needed
MEDDS Improvement		not discussed		
Quality performance measurement		not discussed		
Productivity performance measurement		not discussed		
Operational needs not classified				
Deep mine location and excavation	v. high	staff	R&D needed	Major problem here
Mud flats		not mentioned		
Removing compacted mine and UXO contaminated rubble		not applicable		
Mine Resistant Vehicles	v. high	staff	S. Africa	Staff expressed strong need for use in survey work and route clearance
Triple Canopy Jungle		not mentioned		

Needs Tables - Country Specific

Country or Region of Need	Croatia			
Specific Technical Needs for Deminers Detectors	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	v.high	staff	various (not local)	dogs are being used with machinery to clear vegetation, more are needed, performance tests are becoming an issue with some companies
Sniffer detector	v.high	staff	R&D needed	possibly 30% productivity improvement if reliability can be demonstrated - problems with digs may indicate similar difficulties for vapour-based detectors
Scrub sniffer	v.high	UWA	R&D needed	potentially the most effective way to deal with extensive areas of vegetation which may contain mines
QA detector	v.high	UWA	R&D needed	system capable of checking large areas quickly.
Mineralised soil metal detector	moderate	staff	Trials inconclusive	Problem is known to exist, and several detectors are being evaluated by different groups
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more
Deep target mine detector	limited	staff	R&D needed	Some areas may require this, principally river banks and steep slopes where landslides have buried mines. Large UXO also a problem in some areas
Detector for mines in mud	moderate	staff	R&D needed	many river-bank areas cannot be demined without this capability
Trip wire detector	v.high	staff	R&D needed	need strongly expressed, as this could help reduce time needed for manual clearance, the problem particularly concerning deminers is PROM bounding fragmentation mines. Some non-metallic tripwires, but most contain metal with plastic coating.
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	v. high	staff	Commercial	Several machines in use - this method being widely adopted. Perhaps 20% further productivity gain possible
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	v.high	staff	Commercial, donor	Many groups make extensive use and claim good results. Others claim the work needed to assure complete mine clearance is too expensive and dangerous. CROMAC are enthusiastic and have asked for more machines like this
Backhoe excavators, front-end loaders, possibly armoured.	moderate	UWA	Commercial	Extensive reconstruction work necessary, these machines could reduce time and effort on clearance in ruined residential areas.
Rubble crusher	moderate	UWA	HALO Trust	Power of some fragmentation mines may necessitate heavy armour (PROM-1). No local experience at the moment
Magnetic fragment removal	moderate	UWA	some R&D needed	Could help with reconstructions problems
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		Sticky soil limits ability to pick up fragments, but could help reduce effort needed for manual clearance (when fitted to vegetation clearance machinery).
Saws and vegetation cutting tools	v.high	staff	Commercial	Good quality saws are needed. Deminers often are issued with poor quality tools
Cotton uniforms		not discussed		
Protection from non-explosion hazards	moderate	UWA		cold and wet conditions the major problem
Magnetic probe	limited	UWA		sticky soil, also most fragments are left in ground (probing procedures used)
Low insertion force probe	unknown	UWA	R&D needed	could reduce manual costs by 10%
Smart probe	unknown	staff	Canadian Defence	test results needed
Excavation tools	very useful	UWA	many designs available	HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant on rocky and stony soil areas in south of country. These areas will be important later, not for the time being
Ground and rubble breaker		not discussed		
Ground marking equipment		not discussed		

Needs Tables - Country Specific

Improved personal protective equipment	needed	staff	R&D needed	light weight, comfortable protection from high velocity fragments needed - existing protection helps but better coverage of legs and arms would help reduce injuries from frag. mine accidents
Mine-resistant boots	moderate	staff		desireable for marking minefield boundaries, but some staff think that these give dangerous false sense of security
Scratch -resistant film for visors	limited	UWA	3M product	would extend life of visors
Anti-fog treatment for visors	very useful	UWA		cold, damp conditions frequent
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		UXO are very old and/or badly corroded.
Information/Info Technology Needs				
High quality internet access.	needed	staff	cost problem	Staff officers have E-mail access, but web access too slow for many purposes. Well trained staff could make effective use of internet resources.
Field data recording	useful	UWA		would improve data collection
Data distribution and updating	needed	staff		frustrating problem for staff currently major problem with GIS systems, digital ortho maps can be prepared locally but finance for this is needed
Map and photograph registration	badly needed	staff		potentially valuable in south where vegetation problems are much reduced
High resolution aerial photography	potentially useful	UWA	Commercial	
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis	badly needed	staff	R&D needed	Staff need this to help donors make funds available and evaluate results
Measurement needs				
Dog performance tests	essential if dogs used	staff	local	Evaluation of dog problems needed, performance tests being used on ad-hoc basis by some companies
MEDDS Improvement		not discussed		
Quality performance measurement	needed	staff	R&D needed	Major problem for staff, cause of many disputes and arguments, essential for commercial contract work
Productivity performance measurement	needed	staff	R&D needed	Staff find it difficult to compare productivity data from different organisations
Operational needs not classified				
Deep mine location and excavation	limited	staff	R&D needed	Some problems on river banks and where landslides have occurred
Mud flats	moderate	staff	R&D needed	Problem along river banks (thought to be extensive)
Removing compacted mine and UXO contaminated rubble	moderate	staff		Problem associated with reconstruction work
Mine Resistant Vehicles for civilian use	high potential	UWA	R&D needed	Could help reclaim suspect and lightly contaminate land for use, also potential export market
Triple canopy jungle	high potential	staff	R&D needed	Some very severe vegetation problems, particularly on hillsides

Needs Tables - Country Specific

Country or Region of Need	Egypt			
Specific Technical Needs for Deminers Detectors	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	v.high	UWA	Afghanistan, N. Iraq	possibly 30% productivity improvement possibly 30% productivity improvement, must work with old mines in desert conditions
Sniffer detector	unknown	staff	R&D needed	
Scrub sniffer		not discussed		
QA detector	v.high	not discussed	R&D needed	QA currently difficult
Mineralised soil metal detector		not discussed		
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more many areas cannot be demined without this capability
Deep target mine detector	v. high	staff	R&D needed	many areas cannot be demined without this capability
Detector for mines in mud	moderate	staff	R&D needed	
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)		not discussed		
	limited because of deep mines and UXO		may be provided by USA or Germany	useful in some areas but verification will be difficult, rocky terrain is unsuitable, UXO may damage machine
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).		staff		Mines and UXO are too dangerous to make this feasible in most areas - AP blast mines, grenades are OK.
Backhoe excavators, front-end loaders, possibly armoured.	limited	staff	none	
Rubble crusher		not discussed		
Magnetic fragment removal	limited		R&D needed	Sandy areas with fragments, small UXO.
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards	yes possibly useful			snakes and scorpions, sunburn, dust, problems in mud
Magnetic probe				finding fragments in sandy areas, non magnetic mines
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools	very useful	UWA	many designs available	HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant if improved detection not available
Ground and rubble breaker		not discussed		
Ground marking equipment	potentially useful	not discussed	R&D needed	paint marking on sand could save some time, say 2% improvement, but biggest benefit is likely to be in quality of clearance, and improvement in safety
Improved personal protective equipment	needed	staff	not in Egypt	accident details needed before specifying details, helmets and visors not being used
Mine-resistant boots	needed	staff	France	staff think inflatable overshoes are adequate
Scratch -resistant film for visors	very useful	not discussed	3M product	would extend life of visors
Anti-fog treatment for visors	not needed?	not discussed		warm dry conditions are normal
Universal battery charger		not discussed		
UXO cutter		not discussed		
UXO spinner		not discussed		UXO are very old and/or badly corroded.

Needs Tables - Country Specific

Information/Info Technology Needs

High quality internet access.	needed	staff	cost problem	staff officers need better English to make full use of internet resources
Field data recording		not discussed		no apparent means of utilising this
Data distribution and updating		not discussed		no apparent means of utilising this
Map and photograph registration		not discussed		
High resolution aerial photography	potentially useful	UWA	Air force(?)	needs evaluation, could identify where mines have been exposed by wind
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis		not discussed		
Measurement needs				
Dog performance tests	essential if dogs used	UWA	Afghanistan, N. Iraq	Evaluation of dog potential needed
MEDDS Improvement		not discussed		
Quality performance measurement		not discussed		
Productivity performance measurement		UWA	local	Little appreciation of actual costs - rely on Defence Ministry
Operational needs not classified				
Deep mine location and excavation	v. high	staff	R&D needed	Major problem here
Mud flats	v. high	staff	R&D needed	Major problem here
Removing compacted mine and UXO contaminated rubble				
Mine Resistant Vehicles for Civilian Use				
Tiple Canopy Jungle				

Needs Tables - Country Specific

Country or Region of Need	Jordan			
Specific Technical Needs for Deminers	potential utility	who raised this?	availability	potential benefits
Detectors				
Mine detection dogs	v.high	US military liaison	Afghanistan, N. Iraq	possibly 80% productivity improvement in searching for missed mines
Sniffer detector	v.high	staff	R&D needed	possibly 80% productivity improvement
Scrub sniffer	none	not discussed		minefield locations are known
QA detector	v.high	not discussed	R&D needed	QA currently difficult
Mineralised soil metal detector		not discussed		
Low false alarm rate mine detector	v. high	staff	R&D needed	future productivity improvement 30% or more
Deep target mine detector	v. high	staff	R&D needed	many areas cannot be demined without this capability
Detector for mines in mud		staff	R&D needed	many areas cannot be demined without this capability - areas can be muddy in winter months
Trip wire detector	moderate	not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)		not discussed		could be very useful in thick vegetation, but AT mine rollers would be essential to protect vehicles from known AT mines which are numerous
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	being used now	staff	Commercial or donor	used for risk reduction as part of normal demining process after manual clearance.
Backhoe excavators, front-end loaders, possibly armoured.	very useful	UWA	Commercial or donor	Deeply buried mine areas could be easier to excavate this way
Rubble crusher	none	not discussed		
Magnetic fragment removal	limited		R&D needed	Sandy areas with fragments, small UXO. Could be fitted to other machinery
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools	moderate	not discussed		Could be very useful in thick vegetation
Cotton uniforms		not discussed		
Protection from non-explosion hazards	yes			snakes and scorpions, sunburn, dust, problems in mud
Magnetic probe	possibly useful	not discussed		finding fragments in sandy areas, non magnetic mines
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools			many designs available	mine locations usually known
Ground and rubble breaker	very useful	UWA	not discussed	HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant if improved detection not available
Ground marking equipment	potentially useful	not discussed	R&D needed	no apparent need
Improved personal protective equipment			not in country	paint marking on sand could save some time, say 2% improvement, but biggest benefit is likely to be in quality of clearance
Mine-resistant boots	needed	staff	France	accident details needed before specifying details, helmets and visors not being used
Scratch -resistant film for visors	needed	staff	France	Staff think inflatable overshoes are adequate
Anti-fog treatment for visors	very useful	not discussed	3M product	would extend life of visors
Universal battery charger	not needed?	not discussed		warm dry conditions are normal
UXO cutter		not discussed		
UXO spinner		not discussed		

Needs Tables - Country Specific

Information/Info Technology Needs

High quality internet access.	useful	not discussed	cost problem	staff officers need better English to make full use of internet resources
Field data recording		not discussed		no apparent means of utilising this
Data distribution and updating		not discussed		no apparent means of utilising this
Map and photograph registration		not discussed		no apparent means of utilising this vegetation thick over difficult areas,
High resolution aerial photography	limited use	UWA	Air force(?)	minefield locations are accurately known
UXO render-safe procedures		not discussed		
Socio-economic survey / analysis		not discussed		
Measurement needs				
Dog performance tests	essential if dogs used	UWA	Afghanistan, N. Iraq	Evaluation of dog potential needed
MEDDS Improvement		not discussed		
Quality performance measurement		not discussed		
Productivity performance measurement		UWA	local	Little appreciation of actual costs - rely on Defence Ministry
Operational needs not classified				
Deep mine location and excavation	v. high	staff	R&D needed	Major problem here
Mud flats	moderate	staff	R&D needed	Some problems here along rivers
Removing compacted mine and UXO contaminated rubble				
Mine Resistant Vehicles for civilian use				
Triple canopy jungle				

Needs Tables - Country Specific

Country or Region of Need

Lebanon**Specific Technical Needs for Deminers Detectors**

	potential utility	who raised this?	availability	potential benefits
Mine detection dogs	v.high	UWA	Afghanistan, N. Iraq	possibly 30% productivity improvement
Sniffer detector	v.high	staff	R&D needed	possibly 30% productivity improvement Could help eliminate areas with no contamination
Scrub sniffer	high	not discussed	R&D needed	QA currently difficult
QA detector	v.high	not discussed	R&D needed	Moderate mineralisation problems in some areas
Mineralised soil metal detector	high	UWA	Australia	future productivity improvement 30% or more
Low false alarm rate mine detector	v. high	staff	R&D needed	
Deep target mine detector		not discussed		
Detector for mines in mud		not discussed		
Trip wire detector		not discussed		
Mechanical assistance for deminers				
Ground preparation - vegetation cutter (Flails)	low	UWA	Commercial or donor	Access difficult for machinery, except in Bekaa valley, but farmers have cleared most vegetation
Ground preparation machine (e.g. Flails, Minebreaker, Rhino).	risk reduction	staff	Commercial or donor	In Bekaa valley could be useful risk reduction tool, but trials needed with cluster bomblets Could be useful in reducing clearance costs where large scale soil replacement feasible to save costs of delays.
Backhoe excavators, front-end loaders, possibly armoured.	unknown	not discussed	none	
Rubble crusher		not discussed		
Magnetic fragment removal	limited		R&D needed	Vegetation cover prevents access, but could be useful addition to other mechanised equipment
Personal equipment and tools for deminers				
Water filtration equipment		not discussed		
Saws and vegetation cutting tools		not discussed		
Cotton uniforms		not discussed		
Protection from non-explosion hazards	yes possibly useful			snakes and scorpions, sunburn. current techniques use prodding only, no removal of fragments
Magnetic probe		not discussed		
Low insertion force probe		not discussed		
Smart probe		not discussed		
Excavation tools	very useful	UWA	many designs available	HARC prodder demonstrated, other designs mentioned. Productivity improvement could be significant if improved detection not available
Ground and rubble breaker		not discussed		
Ground marking equipment	potentially useful	not discussed	R&D needed	paint marking on sand could save some time, say 2% improvement, but biggest benefit is likely to be in quality of clearance accident details needed before specifying details, helmets and visors only starting to be used by some deminers
Improved personal protective equipment	needed	staff	not in country	
Mine-resistant boots	needed	staff	France	Staff think inflatable overshoes are adequate
Scratch -resistant film for visors	very useful	not discussed	3M product	would extend life of visors
Anti-fog treatment for visors	very useful	not discussed		cold and damp conditions in winter
Universal battery charger		not discussed		
UXO cutter	limited	not discussed		Likely to be useful, current equipment not known
UXO spinner	limited	not discussed		UXO's are usually removed from construction sites. Neutralisation in place does not seem to be necessary

Needs Tables - Country Specific

Information/Info Technology Needs

High quality internet access. Field data recording Data distribution and updating Map and photograph registration	needed	staff not discussed not discussed not discussed	cost problem	staff officers have good English skills and could make good use of this no apparent means of utilising this no apparent means of utilising this
High resolution aerial photography UXO render-safe procedures	potentially useful very useful	UWA staff	Political problems USA	needs evaluation, could identify where mines have been exposed by weather, but political issues are very difficult because of military occupation of country. Even if assistance provided by Israel, Syrians would probably object strongly and vice versa desperately needed by Army EOD teams for efficient resource utilisation by government
Socio-economic survey / analysis Measurement needs	very useful	researchers	R&D needed	
Dog performance tests MEDDS Improvement Quality performance measurement	essential if dogs used	UWA not discussed not discussed	Afghanistan, N. Iraq	Evaluation of dog potential needed
Productivity performance measurement Operational needs not classified Deep mine location and excavation Mud flats Removing compacted mine and UXO contaminated rubble		UWA not discussed not discussed not discussed	local	Little appreciation of actual costs - rely on Defence Ministry
Mine Resistant Vehicles for civilian use Triple canopy jungle	moderate	UWA not relevant	S. Africa	Agriculture continues in areas contaminated with cluster bombs - protection for farmers could be valuable