

## Research and Development

***ISG judges that Iraq maintained the expertise and equipment necessary for R&D of bacteria, fungi, viruses, and toxins that could be used as BW agents up until Operation Iraqi Freedom (OIF) in March 2003***

- ISG assesses that Iraq's bacterial and toxin BW agents were adequately researched and developed at the advent of the first Gulf war in 1991, and that Iraq had an extensive BW R&D program in the years prior to that. By the time of Desert Storm, Iraq had weaponized *Clostridium botulinum* ('Agent A'), *Bacillus anthracis* ('Agent B') and Aflatoxin ('Agent C') by filling liquid forms of these agents into munitions, although these munitions were not the most effective or efficient for BW dispersal.

***Despite evidence of Iraq's intent to develop more dangerous biological agents after Desert Storm, ISG uncovered no indications that biological agents were researched for BW purposes post-1991, even though Iraq maintained—and in some cases improved—research capabilities that could have easily been applied to BW agents.*** ISG's investigations found no direct evidence that the expertise or equipment were being used specifically for BW work. That said, ISG judges that further R&D on the agents weaponized pre-1991 was probably not required. Additional agents would have required extensive R&D, in ISG's judgement, but despite concerns that surrounded the possible addition of other, more pathogenic, agents into the viral BW program, no evidence has been found by ISG.

- ISG conducted site visits and multiple interviews investigating Iraq's possible possession of smallpox and collected fragmentary and circumstantial information. A definitive conclusion is impossible, but, based on the available evidence, ISG concludes that Iraq intended to develop smallpox and possibly other viral pathogens like CCHF as potential BW weapons. In December 1990, Dr. Rihab informed Dr. Hazim 'Ali that Husayn Kamil wanted him to work on "more dangerous" viruses. According to a source, Dr. Hazim 'Ali was willing to work on other viral agents if Dr. Rihab provided him with the materials. No additional materials were provided. Iraq had the basic capability to work with variola major (smallpox) and may have conducted some preliminary basic research. However, ISG has found no conclusive evidence that Iraq retained or acquired any stocks of smallpox or conducted advance R&D of pathogenic viruses.

ISG uncovered troubling information about post-1991 BW-related endeavours that raise concerns about the legitimacy of Iraq's activities and that suggest to ISG Baghdad aimed at some future time to resume its BW program.

- In the 1990s Iraq decided indigenously to research and produce nutrient growth media that could be used to produce multiple strains of bacteria to include *B. anthracis*, but no direct evidence has yet been uncovered that this media was used to produce *B. anthracis* post-1991. Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion. Research into alternative media for the growth of *Brucella* was conducted following the introduction of the 1990 UN sanctions.
- Multiple sources have told ISG that the *B. thuringiensis* research and production at Al Hakam from 1991 to 1996 was done to provide cover for the equipment and capability at this facility. ISG has not been provided with a good explanation as to why an advanced capability to dry agent in a particle size too small for efficient biopesticide use was established as well. ISG judges that this work advanced Iraq's expertise and knowledge in large-scale drying of *B. anthracis* even if the agent itself was not produced and dried.
- ISG has found that up to five IIS laboratories operated in the greater Baghdad area up until OIF. Additional reporting, though unconfirmed, indicates that the M16 Division also conducted BW related research in two covert laboratories. In the early 1990s, Saddam tasked the IIS to do small-scale BW work in covert laboratories concealed within legitimate facilities. Further unconfirmed reports indicated the IIS conducted BW and CW experiments and stored WMD precursor materials in residences and warehouse around Baghdad through April 2003. Information collected at the time of OIF led to the discovery of assorted laboratory equipment purportedly used by a suspect BW scientist on the Black List at a Mosque in Baghdad. A clandestine laboratory was identified by an ISG team at the Baghdad Central Public Health laboratory in the summer of 2003. According to an employee of the laboratory, the IIS operated a laboratory at that location for several years. In advance of a 1998 UNSCOM inspection, secret documents were removed and stored at the Director's house. In December 2002, the laboratory was emptied of all equipment and documents.

## Building Human Capital

***Over the course of many years Iraq undertook concerted efforts to create the cornerstone of a national BW program: a body of trained scientists with the professional skill and experience needed to develop and produce BW.*** Unlike nuclear and chemical weapons programs, which require vast physical [infrastructure](#), expensive equipment and substantial financial resources, human capital is the essential element of a national BW effort, for scientific research underpins all aspects of a developing BW program. Iraq made the most of a limited pool of qualified personnel to identify and develop the requisite cadre of skilled scientists and technical personnel.

- Trying to develop such a cadre for the BW as well as CW programs was an integral part of the overall Al Hasan Ibn-al-Haytham Institute's goals. UN inspectors discovered that during the 1970s the Al Hasan Ibn-al-Haytham Institute recruited the best and the brightest graduating students—from the Universities of Baghdad, Colleges of Medicine, Science, and Veterinary Medicine, and the University of Mustansiriyyah, College of Medicine. The Institute offered these students [employment](#) with incentives including opportunities for travel abroad and further education. Students selected for biology

then attended a two-month training program at the University of Baghdad, College of Veterinary Medicine, in "laboratory techniques and procedures." Some were selected for graduate studies abroad and some for graduate studies at the University of Baghdad or the University of Mustansiriyyah, while others were given technician positions at the Ibn-Sina Center.

***ISG assesses that at some point after the revitalization of Iraq's BW program in the mid-1980s, a shift in priorities occurred in which Iraqi BW personnel were selected for participation in the program more for their loyalty and dependability than for their technical skills, an approach that distorted the entire higher educational process and frequently ensured that the "best and the brightest" were replaced by the loyal and reliable.***

- A senior Iraqi scientist described to ISG a practice that began in the early 1990s and continued until 2002 as a possible Husayn Kamil initiative. This initiative reportedly named *Al Mumtazin*, or "the distinguished," involved nominating candidates for post-graduate education based on their loyalty to the Regime, institution or superior rather than their technical competence. These "distinguished" candidates reportedly had lesser grades and were generally older than published requirements, according to an ISG interview with a senior Iraqi scientist.
- In a possible bid to counter the corrosive effect of selecting personnel for political and professional reasons, in the mid 1980s, Iraq established a mentoring process through which to conduct investigations into possible BW related bacteria and toxins. This system, used throughout the BW program, utilized compartmented small clusters headed by a senior scientist who had extensive research experience or a senior technician with extensive experience with either the agent or a class of bacteria of interest according to multiple sources who participated in the former program.

### **Research Facilities**

Iraq's R&D to develop BW started in 1974 at the Al Hasan Ibn-al-Haytham Institute. Initially the BW effort was located in a house in the Al 'Amiriyah suburb of Baghdad, and then moved to Al Hasan site number 2, also known as the Ibn-Sina Center, at Al Salman. The biological part of the Al Hasan program was "research on microorganism for military purposes." It included antibiotic and environmental resistance, means of production, and agent preservation. Agents included *Staphylococcus aureus*, *Bacillus* species, *Vibrio cholerae*, botulinum toxin, influenza and polio viruses, and others. Although the militarily relevant piece of the Al Hasan biological program seems to have entered a hiatus with the closure of the Institute, biological activities, not specifically directed toward BW weapons continued unabated at the Al Salman site.

In the formative phases of the BW program, the Ibn-Sina Center was the primary center for BW R&D. Some BW R&D continued unabated at Ibn-Sina Center, which began to broaden in 1984. When Iraq revitalized the militarily relevant BW program in the mid-1980s, Al Muthanna was the primary site until 1987 when the program again moved to the Ibn-Sina Center. However, Al Muthanna continued with specific R&D participation such as that with ricin and aflatoxin on behalf of Al Salman. R&D continued at the Ibn-Sina Center until mid to late 1990 even after much of the BW program moved to the newly established Al Hakam facility in 1988.

In 1990, with the compulsory acquisition of the Al Dawrah FMDV Plant and the Agriculture Water Resource Center (AWRC) facility and R&D and production of aflatoxin moved to the AWRC. In addition, BW-applicable R&D was conducted during the 1980s at TABRC. Al Hakam continued to be a key BW-related R&D facility until 1996, when it was destroyed under UNSCOM supervision. Additionally, Al Hamath, TABRC, and the Tariq Facility (Fallujah III) were also key sites during this period (for more complete information on Iraq's R&D facilities and ISG's exploitations, see Annex B on BW Research and Development).

### **Iraqi BW Agent Research**

***Iraq's efforts to develop BW agents were extensive, and in the years leading up to the first Gulf war Baghdad investigated a wide range of biological agents with potential military applications.*** ISG investigated the extent of Iraq's research prior to the war, and assessed the degree to which Baghdad pursued development of these agents in the aftermath of Desert Storm.

#### ***Bacillus anthracis ('Agent B')***

***Baghdad invested considerable time and effort prior to 1991 in the development of anthrax as a biological weapon. ISG assesses that the effort ended with Desert Storm. However, studies of simulants aided the quality of any future anthrax products.***

R&D on growing the anthrax organism and inducing sporulation was initiated at Al Hasan site number 2, but the work was terminated at the end of 1978. The R&D was reinitiated in 1985 at Al Muthanna. Although denied by Dr. Rihab, the studies may have picked up where the Al Hasan studies left off, and work progressed rapidly and included laboratory production, characterization and storage.

- After the transfer of the BW effort from Al Muthanna to Al Salman, scale up production and aerosol studies (dry and liquid) were conducted. A continued interest in obtaining a suitable dry product and the efforts expended to acquire a suitable drying capability continued at Al Salman and later at Al Hakam.
- Iraq obtained two capable dryers that were air-freighted into Baghdad in 1989. One of these dryers was located at Al Hakam in 1991. Iraq also tried to obtain an "aseptic" spray dryer (identical to those air-freighted to Baghdad, but with additional biological containment capabilities) in 1990. This dryer was not delivered by the supplier.
- Static tests (using simulants for *B anthracis* spores) were conducted in March 1988 in LD250 aerial bombs. Dynamic and static trials using 122 mm rocket warheads filled with simulant were conducted in 1989 and 1990. Trials were then conducted in August 1990 using R-400 aerial bombs, again filled with anthrax simulant.

***ISG continued to gain more insight into B. anthracis work done before 1991, which reinforced the findings of UNSCOM detailed below. However, no new information has been obtained on B. anthracis-specific R&D conducted after the 1996***

### **destruction of Al Hakam.**

- Thamir 'Abd-al-Rahman, a key figure in Iraq's anthrax work pre-1991, told ISG that he attempted to obtain the Ames strain of *B. anthracis* which he considered "very virulent" while attending a scientific workshop in 1989, but he was unsuccessful in that endeavor. Iraq declared researching different strains of *B. anthracis*, but settled on the American Type Culture Collection (ATCC) strain 14578 as the exclusive strain for use as a BW.
- Prior to work on the pathogenic strains of *B. anthracis*, Dr. Rihab directed the scientists to use surrogates in their early and more advanced stages of R&D and production. Accordingly, experiments were done with surrogates, *B. thuringiensis*, *Bacillus subtilis* and *Bacillus megaterium*, in order to determine appropriate growth conditions. Her logic was in part for safety. She wanted to permit the researcher to familiarize and learn procedures with a nonpathogenic organism before attempting to use pathogenic ones. These bacillus strains were used to simulate work on *B. anthracis* by researchers at Al Hakam after 1991. A similar practice apparently was followed 1985-1990. Laboratory-scale work was done with the *B. thuringiensis/sraeliensis* strain at Al Hakam to determine optimized growth conditions. The main work, and ultimate production, of *B. thuringiensis* was conducted utilizing the *Kurstakii* strain. *B. megaterium* was researched at Al Salman in 1987-1988 as a model for *B. anthracis* using a 150l fermentor.
- One large field experiment was also planned and, according to the source, the experiment involved spreading of the bacteria by an airplane. ISG found no further information on this experiment. The information provided by the source confirms existing knowledge about Iraq's use of *B. thuringiensis*, *B. subtilis* and *B. megaterium* as simulants for *B. anthracis*. However, as this is information that comes from a single source, ISG is unable to confirm the veracity of the claim of continued research into *B. anthracis* at Al Hakam following the 1991 Gulf war.
- ISG found information that indicated that research into anthrax vaccines was conducted at the Abu Ghurayb Veterinary College (Baghdad University, College of Veterinary Medicine). Unfortunately, ISG was not able to obtain further information as to what this research involved or what vaccine strain was utilized.

### **Clostridium botulinum (Botulinum toxin, 'Agent A')**

ISG has uncovered no further information to suggest that Iraq actively continued to research and produce *C. botulinum* for use as a BW weapon following the 1991 Gulf war.

R&D on botulinum toxin was an integral part of the Al Hasan site number 2. Efforts appeared to be modest but were focused on growth conditions for maximizing toxin yield. This effort was terminated at the end of 1978 when Al Hasan was dissolved.

Tests then were re-established when the militarily relevant BW program was revitalized in 1985 at Al Muthanna. Seemingly, building on the knowledge gained by the Al Hasan effort, rapid progress was made. By early 1987, before the program was moved to Al Salman, inhalation studies on botulinum toxin were conducted in the 5m<sup>3</sup> inhalation chamber at Al Muthanna.

At Al Salman, studies progressed to where field trials on the dispersal of liquid botulinum toxin using LD-250 aerial bombs were conducted in March 1988. After the move to Al Hakam in 1988, with its larger agent production capability, static (November 1989) and dynamic (May 1990) trials were conducted using 122 mm rocket warheads at the Al Muhammadiyah test range. R-400 aerial bombs were also tested in August 1990 as were the effects of metals (simulating the interior of munitions) on the agent.

### **Clostridium perfringens ('Agent G')**

**No information was discovered to suggest that BW-related research into *C. perfringens* continued after the 1991 Gulf war.**

Following the end of OIF, ISG obtained information relating to *C. perfringens* that essentially confirmed previous UNSCOM findings regarding Iraq's work on this bacterium as a BW agent.

- In late April 1988, Dr. Rihab initiated research on *C. perfringens*, known as 'Agent G', to facilitate its use as a BW agent. The development of 'Agent G' occurred at the Technical Research Center (TRC), Al Salman, and was directed by 'Ali Shihab during the late 1980s. Dr. Rihab instructed the researchers to investigate the various strains and identify the most effective for use as a large-scale BW agent. According to a source, the intent of the research was to disseminate *C. perfringens* as spores.
- The initial stage of the *C. perfringens* project focused on identifying a medium in which to optimize growth. Researchers procured Duncan and Strong growth media and modified the salt and nutrient levels. This initial research on media and isolates occurred in the beginning of 1990. The second phase of the research focused on bench scale production of 'Agent G spores', with the first successful production of *C. perfringens* spores in March 1990.
- As part of the second phase of research, the research protocol called for animal testing to be conducted quarterly and the results forwarded via an official report to Dr. Rihab. ISG has two accounts for the testing that occurred. One source describes research conducted in a small aerosol chamber on rabbits and mice attempting to inoculate abraded skin in these experimental animals. The results obtained through these experiments left the test animals with lesions typical of *C. perfringens* infection. The second account also involves the use of an inhalation chamber to aerosolize spores and infect the laboratory animals but after autopsies were performed, researchers concluded that aerosolized spores may not be effective as a BW agent. They then began injecting 'Agent G' via syringe and this resulted in successful tests using guinea pigs and mice. The animals developed Gas Gangrene infections at the wound sites and eventually died. Results from the successful tests were reported to Dr. Rihab in April 1990, who instructed the researchers to move the production of 'Agent G' to a larger scale.

### **Aflatoxin ('Agent C')**

R&D on aflatoxin began in May 1988 based on previous nonmilitary work on aflatoxin by Dr. Imad. Good progress was made which led to an initial weapons test in November 1989, consisting of static trials with 122 mm rocket warheads. Additional testing involved combining aflatoxin with CS and CN incapacitating agents as well as mustard CW agent. Studies included potency retention under conditions and temperature of deployment as well as effect of metals on the agent. This was followed by

dynamic testing trials in May 1990. However, R-400 aerial bombs and Al Husayn missile warheads were munitions selected for BW weaponization in late 1990.

In 1992, an individual at the Central Public Health Laboratory—who worked for the SSO and was responsible for checking Saddam's food for contamination—denied having an aflatoxin standard, according to a source with direct access but of unknown reliability. According to the same source, the former director of CPHL had been involved in offensive aflatoxin research until at least 1991.

Debriefings since April 2003 of sources formerly involved with BW efforts indicate that Iraq at least continued research on aflatoxin throughout the 1990s. In 1994, a DGS forensics laboratory produced 150 ml of aflatoxin for testing on humans, according to a mid-level scientist who formerly worked in the BW program and visited the site.

### **Brucella**

**Dr. Rihab supported inclusion of brucella in Iraq's BW program and actively supported pre-Desert Storm research to that end. That initiative, however, appears to have ended in the wake of the first Gulf war.**

According to a source, Dr. Rihab wanted to add *Brucella* to the list of BW agents. According to a former mid-level scientist who worked at several Iraqi BW program locations, he conducted research on *Brucella* at Al Hakam prior to Desert Storm and later at Baghdad University until 1992 using imported strains and patient isolates, respectively, according to the scientist. The research included isolating bacterium, growing it in culture, extracting and purifying its toxins, and testing the toxin on mice. Although this research was not declared to UNSCOM, the scientist stated that his thesis was open.

- Rihab and Ahmad Murtada, the Director General of the former TRC, recommended that the scientist conduct the research as part of graduate degree on *Brucella* at Baghdad University under the direction of Alice Krikor Agap Melkonian. Before the war, the researcher conducted laboratory work at Al Hakam and course work at the university. Rihab provided the *Brucella abortus* isolate the researcher used at Hakam but it was not from the *B. abortus* isolates obtained by Rihab from American Type Culture Collection: none of these had been opened. The scientist stopped research on *Brucella* during the war but resumed his work after that at the university, working on isolates from a hospital patient. According to the mid-level scientist, the *Brucella* work was not secret and his thesis about the work was not classified.
- In 1991, after the war, work on *Brucella* restarted at the College of Science with an isolate from a patient at the Ibn-al-Khatib Hospital and was coordinated through the Ministry of Health. During the project, *Brucella* was isolated and grown. The researcher extracted and purified the endotoxin, tested it on mice and determined the toxin was not as effective as Shiga toxin, ricin or botulinum. Rihab received a copy of the researcher's report and work on *Brucella* was supposed to start on the person's return to Al Hakam but it was put on hold by Dr. Rihab in 1992 to focus on research and production of *B. thuringiensis*.
- Research on *Brucella* was also conducted at the Abu Ghurayb Veterinary College, but ISG has no information on the extent of this work.
- Research into alternative media for the growth of *Brucella* was conducted following the introduction of the 1990 UN sanctions. This research was carried out by 'Ali Shihab. ISG found no information to indicate the timescale of research, the results or whether the research was successful.
- After the establishment of the Al Razi Center in 1992, the Microbiology department, directed by Dr. Antoine Al Bana, carried out research into diagnostic kits for *Brucella*. The facility was visited by the ISG BW team who discovered *Brucella* bacterial isolates obtained from Al 'Amiriyah Serum and Vaccine Institute (ASVI) (see [Figure 3](#)). The strains found were *B. abortus* and *B. melitensis*. Although, pre-OIF, the facility had maintained the capability to conduct successful BW-related R&D on *Brucella*, there were no indications that this had occurred.

### **Ricin**

**The evidence surrounding Iraq's investigation of ricin for BW purposes is unclear, and thus ISG can offer no definitive conclusion. It is clear that Baghdad had weaponized ricin in at least a limited fashion prior to the first Gulf war. There is at least some evidence of post-war IIS involvement in ricin research and possible human testing, but ISG developed no definitive information with which to confirm reports of post-war production.**

Iraq's R&D on ricin had its origin in the mid 1980s at the Scientific Research Center (SRC). In 1988/89 active [collaboration](#) was sought from personnel at Al Salman. The research proceeded apace with initial field trials using 155 mm shells in Nov 1990. The work at the SRC was initiated at the behest of an official with the Internal Security Service who followed the efforts through the field trial (see [Figure 4](#)).

ISG conducted a focused investigation into Iraqi work with ricin—a toxin derived from castor beans (*Ricinus communis*) of the indigenous Iraqi *R. communis* plants. The search to date has yielded conflicting information about the use of castor beans and continued ricin work after 1998.

ISG is aware from UNSCOM reporting that Iraq conducted limited weaponization of ricin prior to Desert Storm and that it conducted partially successful field trials with ricin. Based on this, ISG focused on two main themes: (1) part of the Al Tariq Facility—also known as Fallujah II—for castor oil production, and (2) the reported IIS work with the toxin. While ISG has not been able to find direct evidence of recent ricin production, several sources have provided information that suggest that work on ricin toxin continued well past 1992, possibly until the beginning of OIF.

The ISG team examined in detail the Al Tariq Facility and a site that supplied Al Tariq with castor beans—the Al 'Aziziyah farms. The team debriefed a number of scientists and [engineers](#) employed at Al Tariq and a group of farmers from Al 'Aziziyah,

obtaining from each group a very different picture about work at Al Tariq and the intended use of the castor beans. Al Tariq staff employees maintained that castor beans were used exclusively for the processing of castor oil for the brake fluid and tire production industries. They also admitted contemplating the use of castor oil as an anti-foaming agent in the yeast industry. When prompted with a few more specifics, one Al Tariq employee explained away the activity as being pharmaceutical-related. Another shipment of castor beans, for a university, remains to be explained. For more information on this facility, see Annex 2.

***ISG has investigated claims by former IIS officials—a former IIS chemist and his former supervisor, the late Dr. Al Azmirli—that the IIS produced ricin until at least 1995 and possibly until 2003, although ISG has not yet obtained direct evidence of ricin work.***

- Interviews with Dr. Al Azmirli—a former IIS official and scientific advisor to Saddam—revealed that the IIS researched ricin as a BW agent until 2003. He himself was directly involved with ricin work until 1992, when Husayn Kamil demanded the program be turned over to Dr. Rihab and a doctor from the Ministry of Agriculture.
- Dr. Al Azmirli claimed that between 1992 and 1996, ricin was being produced at Al Shameir Hospital in Al Rashad until it was transferred to Al Hakam. A separate former IIS official confirmed that Al Azmirli produced approximately two kilograms of ricin at the Ar Rashidiyah plant in 1991 and 1992. An exploitation of the Ar Rashidiyah plant corroborated the location and presence of a facility, but ISG could not confirm that ricin work had occurred there because of extensive looting.
- Mun'im Mustafa Fatahi, a close friend of Dr. Al Azmirli, reportedly told Al Azmirli that a group of people was actively pursuing ricin for weaponization. As of March 2003, ricin was being developed into stable liquid to deliver as an aerosol in small rockets, cluster bombs, and smoke generators, according to Al Azmirli.
- Documents obtained from Dr. Al Azmirli's residence included an MSc thesis on the topic of ricin written by 'Adnan Jasim from Baghdad University.

**ISG has investigated claims from several sources that work on ricin toxin continued well past 1992, possibly until the beginning of OIF.** The information that ISG obtained on the potential role of ricin in Iraq's BW program post 1991 has primarily been based on single source reporting of unclear veracity.

- The IIS was involved in the research and limited production of ricin for the development of a BW weapon. A source stated that 'Adnan Abd-al-Rasa'il Al 'Ubaydi was responsible for all research related to ricin conducted by the IIS. In 1992, 'Adnan produced a few milligrams of ricin. The IIS was then ordered not to continue with the ricin project because Husayn Kamil wanted the project. The source stated that all research and production processes were turned over to Dr. Rihab and a doctor from the Ministry of Agriculture. A group in Al Hakam was then involved in ricin production after 1992.
- According to a single source, the MIC maintained fields of castor plants in the Al 'Aziziyah area for sale to the Al Tariq [Company](#). According to a source, the castor beans harvested from these crops were allegedly used to make brake fluid and "chemical weapons." When asked if the "chemical weapons" were possibly insecticides or pesticides, the source stated that the "chemical weapons" were used against humans. As the product of a single source, this information is hard to verify.
- During the approximate period of 1994 or 1995, Husayn Kamil, then Head of MIC, gave an order to confiscate farmland that belonged to the source in the area of Al 'Aziziyah. By Husayn Kamil's order, castor plants were to be planted on the acquired land and the MIC remained responsible for delivering the beans for each year's planting. The source also reported that a castor crop was planted every year within different farming areas in the vicinity of the Al 'Aziziyah. To hide the fact that MIC possessed dedicated castor fields, a cover story was developed between MIC and the Ministry of Agriculture or Ministry for Industrial Crops. Wheat, corn and cotton were subsequently planted in the vicinity of the castor crops, as a "cover crop." The Ministry of Agriculture maintained a cover for the MIC in the area of Al 'Aziziyah with offices for project managers. The same source indicated that the cover story was used to deceive UN inspectors.
- All the castor beans grown at this location were delivered to the Al Tariq facility. According to the source no payment was ever made for the castor beans. The only payment that occurred for the overall transaction was to the farmers who worked in the fields. There were various project managers who handled paying the farmers, who were on the payroll of the Tariq facility and ultimately MIC. The castor crops were planted in approximately February and March, and harvested annually in September. Each harvest yielded approximately 250 to 300kg of castor beans. The Al Tariq facility would normally send four or five trucks to the Al 'Aziziyah warehouse to take delivery of the castor beans.
- During an exploitation of the TABRC facility, the team discovered a piece of equipment they determined was associated with de-hulling of castor beans (see [Figure 5](#)). The exploitation team also discovered a 100-ton press containing an oily residue and took a sample of this material. This material returned a positive test for ricin. Although a positive result was obtained this discovery does not indicate on its own any illicit activity on behalf of the facility, as any step in the production of castor oil will return a positive test for ricin. The scale of the equipment was small and no reason was provided as to the purpose of the machinery.

ISG investigated a laboratory at the Al 'Abud Trading Complex, Baghdad. Evidence of ricin was found in samples collected, both by field analysis and at ISG laboratory assays.

- Based on the materials, equipment, and manual found at the site, ISG judged the complex did not appear to be related to the Regime's chemical, or biological weapons programs. Rather, it appears to be an extremist-run laboratory with equipment and reagents that at a minimum could be used to produce ricin. Biological growth mediums and chemical precursors (triethanolamine) were also found in the laboratory.

#### **Wheat Cover Smut ('Agent D')**

R&D on wheat cover smut (bunt of wheat) was initiated in 1984 at the Al Salman site. After the BW militarily relevant program was moved from Al Muthanna to Al Salman, the wheat cover smut project was merged into a fungi and fungal toxin group within Dr. Rihab's group. Smut spores were tested in static field trials in late 1989. Tests to evaluate smut spores as a carrier for aflatoxin were also part of the program. No additional information has been found by ISG related to Iraq's interest in and work on

smut spores.

## **Viruses**

***Prior to the first Gulf war Iraq pursued a range of viral agents as part of its BW program. ISG has uncovered no direct evidence to indicate a renewed interest or organized program to re-establish an Iraqi viral BW program and judges that Baghdad's viral BW effort ended in 1991.***

Researchers involved in Iraq's 1970s BW research at the Al Hasan Institute reportedly attempted to develop influenza virus as a BW agent and were also conducting R&D on polioviruses. There were two virologists in the original group; one was a US trained veterinarian Dr. Muzhir Al Falluji, who had training and experience in animal orthopox (smallpox like) viruses; the other was Dr. Muslih Al Muslih (the 3rd Director of Ibn-Sina Center) who worked on poliovirus. Dr. Al Falluji taught several classes at the College of Veterinary Medicine. The Al Hasan Institute was closed in 1979 and along with it, the viral programs.

Iraq's viral BW program began its research and development (R&D) phases in July 1990 under the direction of Dr. Hazim 'Ali. This was the second known attempt by Iraq to conduct BW viral research. From 1973 until 1978, The Ibn-Sina Center of the Al Hasan Ibn-al-Haytham Research Foundation conducted research at its Al Salman site.

Iraq subsequently revived its BW programme in the mid 1980s. The revival of the Iraqi viral BW program began in early to mid 1990 when Dr. Hazim 'Ali was chosen to lead the effort. Iraq's pursuit of viral BW began over 4 years after the initiation of its research for bacterial and fungal agent development.

According to Hazim 'Ali, the viral BW program ended on 17 January 1991. This information is consistent with an English-language document titled "Viral Agents Program" obtained through the investigations of ISG, which states that work on the viral program began on 1 December 1990 and was cancelled on 17 January 1991, when all specimens were destroyed. This is in contrast to information provided to UNSCOM that included laboratory notebooks and ISG information stating that Dr. Hazim 'Ali isolated and began growing camelpox in October 1990.

Because of pre-OIF intelligence assessments about Iraq's possible possession of smallpox, ISG conducted extensive investigations that included site visits and multiple interviews to determine the validity of this assessment. ISG has collected fragmentary and circumstantial information that provides no definitive conclusions, either way on this issue.

- ISG has collected information from credible sources from the pre-1991 program demonstrating Iraq's interest and intent in developing pathogenic viruses specifically smallpox.
- Further, ISG assesses that Iraq maintained the capability in its personnel and basic equipment to conduct R&D into viral agents including smallpox.
- Finally coinciding with the 1991 Gulf war, Iraq intended to develop a production base to support pathogenic viral production.

## **Camel Pox**

***Iraq's interest in camel pox and its inclusion in the viral BW program have led ISG to assess that camel pox R&D was a surrogate for smallpox research, analogous to the use of nonpathogenic *Bacillus species* and *Bacillus anthracis*.***

According to Hazim 'Ali, researchers in Iraq's BW program followed the practice of working with particularly pathogenic micro-organisms surrogates to facilitate transition to the actual pathogens. This approach permitted the researcher to familiarize and learn techniques, procedures and processes to increase the safety margin for the researcher and technicians.

- In Dr. Rihab's own words, Hazim's decision to work with camel pox was because "it was near to smallpox." When directly questioned about the possibility of smallpox in Iraq, she misspoke on 3 occasions saying "there is no camel pox in Iraq."
- Camel pox was one of the three viruses chosen for the viral BW program by Hazim 'Ali. According to Hazim, no experiments were conducted to determine the effectiveness of camel pox on humans. His decision to develop camel pox was based on his research of citations from standard microbiology and microbial infection textbooks. His recollection was that camel pox causes rare cases of human infection but these were not severe. Dr. Hazim's rationale for the utility of camel pox as a possible BW pathogen remains inconsistent with current and historical published scientific and medical knowledge.

ISG has no information to contradict his statements that his research only succeeded in initial isolation of camel pox from a clinical specimen obtained from the Veterinary Diagnostic Research Center in Abu Ghurayb.

The camel pox sample (scab) was not available immediately but by the end of October 1990, Hazim 'Ali obtained a sample and successfully isolated the virus in chicken eggs. Chicken eggs were inoculated with the camel pox and the results were promising with some characteristic lesions (white pox marks) appearing on the chorioallantoic membrane of the chicken egg. These lesions on the chorioallantoic membrane of a ten-day old chicken embryo were characteristic of infections described in textbooks.

Hazim claims he cannot remember if animal testing occurred. The source stated that a pilot experiment should have been conducted with the isolate to assess for activity in an animal; rabbits are particularly susceptible to camel pox. However, he

could not remember an actual test of the viral isolate on rabbits due to the critical time in which the test would have occurred; the 1991 Gulf war. Hazim does not believe that anyone else could have carried out this experiment in his absence or without his knowledge.

Hazim investigated existing facilities in Iraq for scaling-up the production of camel pox if and when that was possible or necessary. He decided on using the chorioallantoic membrane method of viral egg production. Although denying a plan for large-scale production, he inspected the Veterinary Service Center in Irbil. It was used in the production of animal vaccines for Newcastle disease and fowlpox. The Irbil facility had a moderate scale egg production capability but according to Hazim an untrained staff. The large size of the facility required was explained due to the fact that the amount of virus obtained through this method would only average 5 mg of tissue.

This facility was autonomous to the Iraqi Government and an order to commandeer the plant for Hazim's activity was signed by the Minister of Agriculture. However, the order was never implemented.

Dr. Hazim 'Ali's performance in leading and conducting Iraq's fledgling viral BW research, based on comments by his colleagues, was underwhelming. Rihab described him as "not a man to work by himself." Dr. Nasir Al Hindawi commented that Hazim 'Ali did not produce a single virus.

### **Smallpox**

***ISG concludes that Iraq had a pre-1991 intent to develop smallpox as a strategic viral BW agent and had the basic capability to work with variola major (smallpox). However, ISG has collected no direct evidence that Iraq either retained or acquired smallpox virus isolates or proceeded with any follow up smallpox related research. ISG assesses, however, that Iraq did have the capability to conduct research into smallpox, if not in a manner up to Western BL-4 containment standards. Iraq possessed facilities such as the Al Dawrah Foot and Mouth Disease Vaccine Plant and Al Razi Center had equipment that could potentially be used to work on high-risk agents such as smallpox.***

Prior to OIF, the US intelligence community assessed that Iraq probably retained samples of the smallpox virus and may have been researching it for BW purposes. It was also stated that it had no information indicating whether such work was ongoing. Despite the limited information gained by the UN and a claim by a senior player in the CBW program that the intent of the viral BW program was to weaponize smallpox, the additional information uncovered by ISG has not provided evidence of an R&D effort to weaponize smallpox.

- According to Dr. Mahmud Farraj Bilal Al Sammarai, a senior official involved in the weaponization and testing of CBW agents, the aim of the viral BW program was intended for the weaponization of smallpox. He states that Dr. Hazim 'Ali started with Camel pox since it was easier to work with for development, but ultimately the program was intended to progress to smallpox. Dr. Bilal did not know for a fact that samples of smallpox existed within Iraq but stated that 'Ali might obtain them from the Baghdad Central Public Health Laboratory or collections at the Al 'Amiriyah Serum and Vaccine Institute (ASVI). Dr. 'Ali Mukhlif, Dr. Hazim 'Ali's sponsor to work with the TRC, told Bilal the intention of the program and Hazim's activities during a meeting at Al Muthanna in 1990.
- During investigations conducted by ISG and earlier by UNSCOM, Dr. Hazim 'Ali occasionally referred to "smallpox" when questioned about their research and quickly retracted the statement to say "camel pox." The source was unable to provide an explanation as to why he repeatedly made this mistake. This type of mistake added to the confusion surrounding Iraq's possible R&D efforts on smallpox. Hazim stated that he would not be surprised if smallpox isolates were found in Iraq and identified two culture repositories where viral cultures could be maintained over extended periods of time: Al Dawrah FMDV Plant and the Baghdad CPHL. None were found by ISG. However, the CPHL seed stock repository was reported to have been systemically looted post-OIF (see below, under "Feasibility of Maintaining Smallpox Cultures from 1972) and the Al Dawrah FMDV Plant was effectively shut down and electricity turned off after it was rendered unusable in 1996.

Contrary to comments made by Dr. Al Hindawi that there were no virologists in Iraq, ISG identified and interviewed close to a dozen, mostly US and UK trained, highly capable PhD virologists. Several had experience with orthopox (smallpox like) viral research experience mostly with animal related pox viruses. One actually performed genetic engineering research on animal pox viruses attempting to develop a recombinant animal vaccine. A couple had experience working with the smallpox vaccine strain (vaccinia). However, none of Iraq's "best and brightest" virologists were assessed directly involved in Iraq's BW efforts. After extensive interviews, none could provide direct information concerning the existence of historical or recent smallpox isolates or research. (See the accompanying textbox on reported Iraqi retention of smallpox isolates.)

### ***Iraqi Retention of Smallpox Cultures***

***ISG cannot be certain whether or not Iraq had smallpox seed stock to OIF. ISG investigated Iraq's technical and practical capabilities to maintain viral or clinical smallpox isolates from the early 1970s in Iraq. Interviewing a number of senior Iraqi scientists and virologists ISG could make no definitive conclusions. ISG notes the stated intent of Husayn Kamil in 1990 to develop more virulent viruses as part of the BW program. While Hazim did not accomplish this objective, ISG cannot rule out the possibility that other, yet unidentified, researchers were given the responsibility to attempt to do so.***

***In 1978, Ministry of Health (MoH) reported to the World Health Organization that no smallpox cases had occurred in Iraq since an outbreak in 1972, and attested in writing that all remaining smallpox cultures and clinical specimens were destroyed in 1978. There was, however, no independent verification of the destruction of smallpox isolates or clinical specimens that may have***

been retained by either clinical or research institutes, and subsequent reporting on the subject is contradictory:

- One source ISG interviewed was an advisor to the Iraqi Minister of Health between 1980 and 1982. He stated that he was "90% certain" that Saddam did not destroy the last smallpox samples.
- Contrarily, Rihab stated categorically that no isolates of any kind were inherited by her from the original 1970s BW effort.
- According to a senior Iraq scientist at Al 'Amiriyah Serum and Vaccine Institute, he was ordered by MoH urgently to produce 3.5 million doses of smallpox vaccine in 1980. This source was the principal responsible scientist involved in this effort. By his accounts, the Iraqi MoH attempted to procure smallpox vaccine seed stocks from the World Health Organization (WHO) in 1980 for this effort. The WHO refused Iraq's request citing the recent success in the eradication program.
- Intelligence reports dating back to 1994 suggest that Iraq may have obtained smallpox cultures from the former Soviet Union (FSU) in 1992. A biologist who had indirect access to this information stated that Iraq acquired isolates of smallpox from Russia in 1992. He went on to describe an effort to develop smallpox for the BW program from 1992 to 1994. He described efforts to grow the virus in both eggs and tissue culture. This effort reportedly failed and the viral cultures were maintained at the CPHL. The subject biologist is no longer in Iraq.

ISG has collected no information with which to conclusively refute or confirm the existence of smallpox isolates retained by Iraq from the period when the disease was still endemic, but if they were retained they would have been a potentially serious threat in the context of a renewed BW program.

- ISG assesses such viral cultures could remain viable for extended periods of time depending on the nature of the isolate, facility conditions and the overseeing scientist. Clinical smallpox specimens would be less likely to survive long-term storage unless they were held in liquid nitrogen. Frozen lyophilized smallpox isolates could, on the other hand, have an extended shelf life and probably remain viable for decades. Several institutes in Iraq had nitrogen freezer storage capabilities.
- ISG did learn that as late as 1992, Iraq was assessing the viability of smallpox vaccine it produced in the 1980s. A scientist who was involved in the production of the smallpox vaccine in the 1980s was asked to test samples presumably from that stockpile. The vaccine was found nonviable. At that time, he recommended that all remaining vials of that vaccine be destroyed. He does not know if that recommendation was followed. Separately, ISG learned from Dr. Hazim 'Ali that a researcher at the Baghdad University Medical College was actually producing smallpox vaccine in 1996, for whom and for what purpose are unknown.

Baghdad College of Science was identified as one possible location for smallpox work prior to OIF. An ISG subject matter expert team visited the University of Baghdad, College of Sciences on three separate occasions and toured the facilities in late May and early June 2003. The visit observed generally old, poor condition, and sparse laboratory equipment. The team inspected a room (room 179) marked "Graduate Studies" which had locks on both doors. The room contained a large autoclave. The room had two large overhead fume hoods of the type used in restaurants to filter the air within the room. There was one small plastic class I safety cabinet, several shaker incubators, a glove box, old bottles of culture media. No freezers or liquid nitrogen containers were identified. During the course of its investigations, ISG inspected the Al Kindi veterinary vaccine facility. This facility was similar in function to the one Hazim 'Ali investigated in Irbil in autumn 1990 that produced Newcastle and animal pox vaccines.

- ISG inspected the production buildings and observed that the equipment appeared to be for the expressed purpose of producing Newcastle virus vaccine in chicken eggs; however, this dual-use equipment was assessed to be easily diverted to produce Variola (smallpox) or other pathogenic viruses (see [Figure 6](#)).
- ISG also visited the building where animal pox vaccines are produced in tissue culture. Their assessment was that with the Newcastle vaccine unit, the equipment in this building could also be used to produce large amounts of smallpox virus in tissue culture although all equipment present is consistent with the expressed purpose of making animal vaccines.

ISG learned of a television news report that was broadcasted on Western television in mid-April 2003 that reported the CPHL had been looted of highly infectious virus such as smallpox, polio and influenza. ISG visited the latter and interviewed senior researchers who described the incident. Several visits to the CPHL and interviews with scientists and researchers have not shed further light into the existence of smallpox cultures being stored there. ISG did identify a "secret lab" that was operated there, which had been vacated in December 2002. The nature of the research in that laboratory was not determined.

### **Crimean Congo Hemorrhagic Fever**

**While Iraqi explanations for why CCHF was not considered for the BW program remains unsatisfactory, there is little substantial information to contradict the explanation.**

Hazim 'Ali argued against CCHF being considered endemic to Iraq but did not deny that a sample could be obtained during the cyclical infection season. According to Antoine Sabri Al Bana, Iraq's leading CCHF expert, the virus circulated widely in herd animals such as donkeys, sheep and goats.

- Some cases of CCHF occurred in Iraq during the time Hazim 'Ali was studying overseas and described an incident involving physicians, who unaware of the virus and its symptoms, were unprotected whilst treating infected patients. As a result, some of the physicians acquired CCHF and died. Hazim 'Ali used this example to illustrate the introduction of the virus into Iraq and that it was not actually endemic to the country.
- According to Hazim 'Ali, two researchers from the Veterinary Medical College worked together on diagnosing and isolating CCHF in the 1970/1980s. The duration of the experiment and the extent to which testing was conducted using

animals, remains unknown. Hazim 'Ali claims not to know where exactly the practical isolation of the virus occurred because of a lack of sufficient containment to work with the virus and no vaccine was available at the time. The work of the two researchers was published. Isolation of the first case of CCHF in Iraq occurred in 1979.

- In 1996, a CCHF outbreak occurred that resulted in over a 100 cases. Most cases were seen at the Al Khatib hospital, near Tuwaitha, south of Baghdad. The mortality rate even in treated cases approaches 50 percent.

#### **Acute Hemorrhagic Conjunctivitis (Enterovirus 70)**

**ISG has investigated, but has found no information to suggest that BW-related research into the contagious agent acute hemorrhagic conjunctivitis (AHCV) occurred after the alleged cessation of the Iraqi viral BW program in early 1991.** The Enterovirus 70 strain that causes AHCV was introduced to Iraq in the 1970s.

- The documented work conducted on isolating AHCV was unsuccessful according to Dr. Hazim 'Ali. A senior virologist involved in the Iraqi BW program attempted to isolate Rotavirus and AHCV from clinical isolates. When the source isolated AHCV and had evidently obtained cytopathic results, the isolate was infected into Hep2 viro cells. The results of the test were unsuccessful.

#### **Rotavirus**

**According to the senior level viral researcher, Rotavirus, which causes an acute gastroenteritis, was chosen because of a theory at the time that as Americans were "more hygienic", they might be more susceptible to infection with rotavirus.** Little new information has been uncovered by ISG surrounding Rotavirus, the third virus chosen for the Iraqi viral BW program.

- Work was done to isolate the virus from clinical samples but ISG has no additional information to indicate the success of these attempts.

#### **Other R&D Related to BW Development**

##### **Biopesticides**

**ISG judges that, following Desert Storm, in mid-1991, Al Hakam shifted its focus from Bacillus anthracis production to Bacillus thuringiensis, a biopesticide and a simulant for B. anthracis, as a mechanism to preserve a key segment of Iraq's BW production base.** This shift in focus allowed Iraq the opportunity to continue the pursuit of relevant technologies and processes—such as the development of an entirely indigenous growth media and the drying of biopesticide—that could further achieve its desire for self-sufficiency in BW.

- Multiple sources told ISG that in order for Rihab's former anthrax group to produce Bt, they required the assistance of scientists at TABRC who had been researching alternatives to chemical pesticides like *B. thuringiensis* since the early 1980s. ISG learned from several sources with direct access that Al Hakam developed *B. thuringiensis* production to cover past anthrax production and to preserve production infrastructure for the future.
- An Iraqi scientist and former head of the anthrax program told ISG that from 1992-1995 TABRC provided the seed inoculums to Al Hakam for industrial-scale production of Bt. However, ISG has no information to suggest that TABRC was involved in production of *B. thuringiensis* in quantities larger than the bench-scale amounts required for experimental purposes.

##### **Bacillus thuringiensis (Bt)**

*Bt is a biopesticide that is widely available on the international market and therefore, trade restrictions aside, it is not immediately apparent why Iraq should choose to develop its own production process from scratch. ISG assesses that there are many companies that would be willing to supply Iraq with Bt and/or sell it a license to produce the material. ISG is unable to find any indication that preproject planning work—market considerations, least cost / most effective method for Iraq to enter the bio-insecticides business—was ever conducted in relation to Bt.*

**ISG judges that the TABRC became the primary facility continuing B. thuringiensis research after Al Hakam's destruction in 1996, but ISG lacks evidence that this research was intended as a simulation for B. anthracis research.** However, undeclared pieces of equipment including fermentors were found at TABRC by ISG and an important former *B. anthracis* production expert was reported to have worked routinely at the facility from 2000 to 2003, which makes ISG suspicious of the true nature of the work done there.

- An ISG exploitation team found undeclared fermentation vessels and an underground storage area with other dual-use biological production and processing equipment at TABRC in October 2003 (see [Figure 7](#)).
- Thamer 'Abd-al-Rahman, who was declared to the UN as involved in Iraq's *B. anthracis* BW project, worked at the TABRC one day a week beginning in 2000 on a SCP project, according to an Iraqi microbiologist with direct access, but unknown reliability. Thamer also was reported to have possibly helped a *B. thuringiensis* researcher at the TABRC, Jabbar Al Ma'dhihi, with some viability tests on *B. thuringiensis*.

Multiple sources told us the primary mission of the TABRC was agricultural science R&D. The majority of TABRC's activities involved crop improvement and integrated pest management. As part of the Iraqi Atomic Energy Commission (IAEC) within the Tuwaitha Nuclear Research Complex, the facility had a mature scientific staff with expertise in recombinant DNA technology, microbiology, entomology, and access to agricultural pathogens, according to an Iraqi microbiologist of unknown reliability.

- Dr. Al Ma'dhihi—former TABRC Director—oversaw research into the biopesticide *B. thuringiensis* and considered it as a replacement for chemical pesticides in Iraq, according to an Iraqi scientist and former head of the anthrax program. Under Al Ma'dhihi's direction, TABRC reportedly conducted successful research into efficient small-scale production and drying of *B. thuringiensis* that could potentially be applied to the BW agent, *B. anthracis*. ISG is uncertain whether informal or formal collaboration between TABRC and the Al Hakam factory occurred before 1991.

- Some of the research into the genetic modification of *B. thuringiensis* done at TABRC in conjunction with the Department of Biotechnology at Saddam University (now known as Al Nahrain University) from 1999-2003 used polyethylene glycol protoplast fusion methods, followed by screening, to produce a new strain of *B. thuringiensis* that would display high levels of biomass production as well as infectivity, according to an Iraqi microbiologist. ISG judges—based on this research—that the TABRC had genetic engineering capabilities that could be applied to BW agents like anthrax, but have found no evidence to date that such work was done.

### Simulants

Generally, 'simulants' are closely related to the BW agent that they are substituting for, but lack the pathogenicity of the BW agent in humans. The rationale for the use of a simulant is that it can be safely used for a variety of purposes such as to accurately assess production methods, storage conditions, weaponization parameters, and dispersal techniques. Many simulants can also be used for a variety of legitimate civilian activities and therefore provide cover stories for BW programs.

### Single Cell Protein R&D

ISG has found no direct evidence that the post-1995 work carried out by TABRC into SCP was used to cover continuing research into the production of BW agents, like what was done at Al Hakam. Testing of samples taken during site exploitations at TABRC and its SCP production subordinate, Al Hamath, by a US coalition BW exploitation team were negative for *B. anthracis* and *C. botulinum* (see Figure 8). ISG assessed that a thorough decontamination procedure or, more likely, that no large-scale R&D or production of known BW agents occurred at these facilities.

- An Iraqi microbiologist told ISG that the TABRC's SCP academic research began in the early 1990s and involved research, experimental testing, and pilot plant production. The work also involved the development of a process for upgrading the nutritional quality of the agricultural residues and wastes.
- The Al Hamath facility worked on a project for the pilot plant scale production of citric acid using *Aspergillus niger*. The process was abandoned when it was discovered that the strain of *A. niger* used was unsuitable for use in submerged culture as the mycelium suffered damage under the continual agitation required for submerged culture. Two 750l bioreactors from the abandoned citric acid production project were set aside for SCP work at Al Hamath but only one of the bioreactors was functional.

### Single Cell Protein

SCP is cell or protein extracts from micro-organisms, grown in large quantities for use as protein supplements, for example in animal feeds. SCP production is used to alleviate problems of protein scarcity and can be used to replace costly conventional sources such as soy meal and fishmeal. The use of agricultural and industrial wastes for bioconversion to protein rich food and fodder stocks has the additional advantage of making the final product cheaper.

### Growth Media R&D

ISG judges that beginning in the 1990s Iraq decided indigenously to research and produce nutrient growth media that could be used to produce multiple strains of bacteria to include *B. anthracis*, but no direct evidence has yet been uncovered that this media was used to produce *B. anthracis* post-1991. Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion.

- Dr. Al Ma'dhihi was responsible for the development of an indigenously produced media with ingredients that did not come under UN scrutiny as a result of the sanctions against Iraq. Importantly, laboratory notebooks suggest the media was very effective in inducing nearly one hundred percent sporulation of the *B. thuringiensis*, a known simulant for the BW agent *B. anthracis*, with few or no additives or intensive monitoring of the fermentation process.
- During January 2004, ISG obtained a laboratory notebook dating back to 1989 detailing experiments conducted using Dr. Al Ma'dhihi's locally produced milk byproduct/corn byproduct media and the *B. thuringiensis* variant *Kenya* with impressive sporulation results. The notebook outlined experiments concerning the effect of different concentrations of the media and additives on sporulation of *B. thuringiensis*. These results were consistent with the claims made for the effectiveness of the media. One experiment detailed in the notebook showed that per 24-48 hours growth of *B. thuringiensis* in this locally produced media, there was 100 per cent spore growth with a resulting viable count of  $1.2 \times 10^8$  to  $5.6 \times 10^8$  per milliliter.
- Dr. Al Ma'dhihi's media was essential to a possible Iraqi BW program as the media was made up of the simple local ingredients, which are both by-products of other food production processes. The milk byproduct, in particular, is a waste product. At Al Hakam, the corn byproduct was made from cornstarch produced at the Al Hashimiyah State Factory in Al Hillah near Babylon. The milk byproduct was obtained from an unnamed dairy at Abu Ghurayb. Besides being indigenous and cheap it was impossible to monitor or account as part of a UN verification process.
- This locally produced media were utilized in the *B. thuringiensis* production process at Al Hakam and with growth requirements of *B. thuringiensis* being very close to *B. anthracis*, the whey/CSL media could potentially have been used at Al Hakam to produce *B. anthracis*. Dr. Rihab and Thamer 'Abd-al-Rahman, the director of the *B. anthracis* project at Al Hakam, have both stated in interviews to ISG that they are unaware of any tests on growing *B. anthracis* in the milk and corn byproduct media. This is an odd statement because both individuals co-authored a document that evaluated various growth media for growing Bacillus species including *B. anthracis* such a commercially available media.
- Thamer goes further to state that there was no reason to replace the modified G medium declared as used in the anthrax programs as it was reliable, produced high sporulation rates and was made from simple salts commercially available within Iraq, and therefore there was no need to hide procurement signatures. However, Modified G medium (MGM) cannot be used alone to grow *B. anthracis* spores. MGM requires that the anthrax organism be grown in a very enriched medium first and that relative large inoculums be used in the last step of fermentation that uses modified G medium. Thus

using an alternative to the enriched medium and MGM would have a material advantage to minimize sanctions scrutiny. Furthermore, at the time of production of *B. thuringiensis* at Al Hakam, Iraq was under increasing scrutiny on the material balance of growth media from UNSCOM.

Dr. Rihab admitted to ISG that use of such a locally developed milk and corn byproduct *B. thuringiensis* media would permit evading monitoring of media to track fermentation activity.

- An anthrax expert's assessment was that it was highly probable that this media would achieve similar rates of sporulation in anthrax production.

Dr. Rihab described to ISG her BW group's research in developing indigenously produced media to circumvent the effects sanctions imposed on Iraq after the 1990 invasion of Kuwait.

- Dr. 'Ali Shihab did media work for an unspecified microbe. Shihab was the lead scientist for *Clostridium perfringens* development. ISG assesses that he was probably working on an alternative growth media for that organism.
- Nasr Al Hindawi worked on alternative media for *Brucella* that was a candidate BW agent undergoing basic research in the period coinciding with Desert Storm.
- After 1992, Baghdad University worked on plants as a source of bacteria growth media; the plant media was apparently suitable for pathogen growth, and Dr. Rihab had expressed her concern that it might attract the attention of UNSCOM.
- Around June 2002, Dr. Al Ma'dhihi produced about five vials of *B. thuringiensis* formulated with bentonite and asked Thamir, who was working with Dr. Al Ma'dhihi twice a week at TABRC, for an assessment of their viability by re-growing them in a small volume shake flask culture. One of Dr. Al Ma'dhihi's MSc students was working on this organism, although no other specific reason for this work was given. Thamir cultured approximately two of the samples, with one of the resulting cultures exhibiting good activity of 80 to 90 percent mortality of test organism, the other performed poorly.

### Drying Process/Carrier/Particle Size

**Multiple sources have told ISG that the *B. thuringiensis* research and production at Al Hakam from 1991 to 1996 was done to provide cover for the equipment and capability at this facility, yet ISG has not been provided with a good explanation as to why an advanced capability to dry agents in a particle size too small for efficient biopesticide use was established.** An UNMOVIC document from March 2003 on Iraq's Unresolved Disarmament Issues says that the particle size would have had little use in agriculture and that UNSCOM determined the *B. thuringiensis* strain used did not produce biopesticidal proteins, so it would not have had any utility as a biopesticide. ISG judges that this work advanced Iraq's expertise and knowledge in large-scale drying of *B. anthracis* even if the agent itself was not produced and dried.

- Iraq successfully dried *B. thuringiensis* utilizing bentonite as a carrier and drying agent. According to a source, only one grade of bentonite was available in Iraq and particle size was dictated by this. The bentonite was supplied through the Ministry of Industry and Minerals (MIM) mining company. Talc was also successfully tested as a carrying agent but was determined to be too expensive for production. Acetone was experimented with at Al Hakam as a drying agent, but was found to be too expensive for large-scale production.
- According to a source, at Al Hakam the dried *B. thuringiensis* was crushed into 1-10 m sized particles but ISG has found no information on who decided on this particle size. The same source claimed that the farmers using the *B. thuringiensis* from Al Hakam did not like the size of the particles since it made direct dusting onto plants difficult. Al Hakam had plans to enlarge the particles to granular size but they had not completed this work when the facility was destroyed in 1996.

Information surrounding the intended application of *B. thuringiensis* remains contradictory with no consensus on whether it was to be applied wet or dry. A senior researcher involved in the BW program has indicated that the *B. thuringiensis* was intended for use against corn borers as a wet or dry application by farmers. Sources are generally consistent in their assertion that the *B. thuringiensis* was never intended or tested for aerial application. Although the information available suggests Iraq successfully dried *B. thuringiensis* and produced the 1-10 m particle size applicable for efficient BW agent dissemination, ISG has found no information that Iraq actually used the same process to produce weaponizable dried *B. anthracis*.

### Production Capability

ISG judges that between 1991 and 1996 Iraq possessed an expanding BW agent production capability. From 1996 to OIF, Iraq still possessed small but significant dual-use facilities capable of conversion to small-scale BW agent production. ISG has found no evidence that Iraq used this capability for BW production.

- Iraq maintained—and tried to improve where possible—a smaller, but capable, “legitimate” fermentation capability at agricultural and educational sites that could have been used to produce small but significant quantities of BW agent. ISG, however, uncovered no information that Baghdad did so.
- Samarra Drug Industries, for example, had the fixed assets that could be converted for BW agent production within 4 to 5 weeks after the decision to do so, including utilities and personnel with know-how and equipment, not all of which had been declared to the UN. Site buildings contain numerous jacketed process tanks ranging in capacity from 100-10,000 liters together with ancillary equipment such as filter presses, autoclaves and bio-safety cabinets.
- ISG cannot disprove the existence of Iraqi transportable fermentations systems that could have been used for BW. That said, no evidence has been found to date that there were such systems. ISG judges that the two mobile trailers found near Mosul and Irbil were not for BW production (see the accompanying annexes on mobile production facilities for further information).

**Iraq relied heavily on imported equipment and supplies to conduct its BW program, was dependent upon dual-use civilian**

**facilities to produce BW agent, and took steps to mitigate the impact of sanctions on its ability to pursue potential BW agent production.**

Iraq relied on equipment that had been imported for civilian purposes for the production of BW agent prior to the first Gulf war, and demonstrated the ability to quickly adapt civilian facilities to BW agent production. This equipment was relocated to a purpose-built BW facility, Al Hakam, where the production of botulinum toxin was started in 1988. The production of anthrax spores and *C. perfringens* (the causative agent of gas gangrene) followed later. Civilian facilities were requisitioned in 1990 for the production of aflatoxin (the Agriculture and Water Resources Center, Al Fudaliyah) and for the production of additional quantities of botulinum toxin and possibly anthrax (the Foot and Mouth Disease Vaccine Plant, Al Dawrah). After the war these facilities reverted back to their former use, and Al Hakam was disguised as a SCP (yeast) and a *Bacillus thuringiensis* (biopesticide) production plant.

- Prior to the construction of Al Hakam, alternative locations and options were considered by the Iraqi authorities. This included the possibility of having mobile production facilities. Pre-OIF intelligence reports indicated that Iraq had such facilities.

**Baghdad's BW production centered on a number of important fixed facilities. The facility at Al Hakam was perhaps the most important, but Iraq pursued BW in a range of locations.**

Iraq initiated production of BW agents (for field tests) at Al Salman in 1987 using seven laboratory fermentors (7- and 14-liter vessels) and two small production fermentors. Regarding the two small production fermentors, one was acquired in 1987 from the At Taji single cell protein (SCP) project (300 liter) and the other was a 150-liter fermentor purchased while the program was at Al Muthanna. A medium capacity spray dryer also was transferred from the At Taji SCP Plant to the BW program in 1987.

After the Al Hakam facility (northern production area) became functional in 1988, the 300 liter and 150 liter fermentors were transferred to the new facility. Additionally, a larger scale production capability was acquired by moving the Clostridial vaccine production line from Al Kindi Veterinary Research Facility (later named the Veterinary Vaccine and Drug Production Facility [VVDP]) to Al Hakam. This collection of fermentors and tanks—reported by the supplier to be fermentors—consisted of two 1,850-liter fermentors, one 1850-liter tank, and six 1480-liter “tanks” and eight 800-liter mobile “tanks.” The 1,850-liter fermentors and six 1,480-liter “tanks” were all used in production of BW agents. Iraq asserted the mobile tank was used only for storage and transport of bulk agent. A second spray dryer that could produce small particles—one of two air-freighted from a supplier to Baghdad in 1989—was located at Al Hakam at the time of its first UN inspection in September 1991.

In 1990, additional production capability was acquired for the BW program with the addition of Al Safa'ah (Agriculture and Water Resources Center at Fudaliyah) and Al Manal (Al Dawrah Foot and Mouth Disease Virus (FMDV)) facilities to the BW program. Al Safa'ah possessed a sizeable fermentation line consisting of several 400-liter fermentors and associated other tanks. Additionally, the facility had several incubators including one walk-in incubator, which allowed for some creative stacking of glass flasks said to be used for aflatoxin production. Al Manal had valuable high containment capacity for R&D and contained: one 125-liter mobile tank; one 141-liter and one 236-liter seed fermentors one 1,425-liter and two 2,100-liter fermentors; two 2,550-liter mobile tanks; two 2,600-liter, two 2950-liter, and two 3,500-liter fermentors. Of these, assortments of 2,600-liter and 3,500-liter fermentors were used to provide a capacity for 1,200 liters (10X concentrated) of agent per batch (not all of the available capacities were said by Iraq to be used in this production process) (see [Figure 9](#)).

Additionally, other sites had production capability of a more limited scale, e.g. Al Kindi Veterinary Research Laboratories (Al Kindi VVDP facility) and Al 'Amiriyah Serum Vaccine Institute (ASVI), or capability that would require modification on a limited scale, e.g. Samarra Drug Industries. The Al Kindi VVDP facility retained one 1,850-liter tank—damaged during Desert Storm, when the other tanks and fermentors were transferred to Al Hakam. Production for viruses and bacteria employing glass flasks and embryonated eggs were less efficient but ample.

- Iraq declared work on larger-scale fermentation systems for SCP, and on a capability to produce large-scale quantities of a commercial biopesticide in the first UNSCOM inspections in the years immediately following the 1991 Gulf war. Many former officials told ISG that Iraq aggressively worked from 1992 to 1995 at Al Hakam to improve the production and processing of SCP and the biopesticide *B. thuringiensis* in an attempt to save the facility from being destroyed by UNSCOM.

From 1991 to 1996, Iraq continued to expand its dual-use production capability at Al Hakam—until the facility and equipment were destroyed under UNSCOM supervision in May-June 1996. Fermentors and associated equipment were transferred from Al Safa'ah to Al Hakam. Indigenously produced fermentors, 2.5 cubic meters and 5 cubic meters, were installed in the southern production area. These were assessed by international experts as “not fancy but functional” although Iraq has stated to ISG that the 5 cubic meter fermentors were not functional due to propeller shaft problems. Large physical plants were constructed in anticipation of acquiring two 50 cubic meter turnkey fermentation systems. These were not delivered.

**To avoid sanctions imposed after Iraq's invasion of Kuwait, Iraq initiated a program to develop the in-house manufacture of media and media components suitable for the growth of bacterial BW agents, see Section on R&D. ISG site exploitations have revealed sites with the potential to undertake growth media production.**

- The large-scale production of bacterial BW agents is a multi-stage process that requires a growth medium suitable for the selected organism together with a ‘train’ of specialty, and fermentation equipment. Because of sanctions and UNSCOM inspections, beginning in 1990 Iraq had difficulty obtaining an external supply of growth media for large-scale production of BW agent. By 1992, UN inspections, mandatory declarations and UN monitoring of growth media importation and use

created further impediments for any Iraqi biological production effort. Rihab apparently began an effort in 1990 first with some of her BW researchers, and then later with at least one scientist at the IAEA TABRC, to develop bacterial growth media from indigenous sources. Rihab stated that when the effort was initiated in 1990, the intent was to circumvent sanctions placed on Iraq. ISG does not have evidence that this effort was originally intended to enable clandestine production of BW agents, but nevertheless provided some capability in this regard.

The production capabilities at Tuwaitha continued to expand during this period. The FMDV Plant at Al Dawrah remained functional until it was partially disabled under UN supervision in 1996; selected fermentors and tanks—identified as used in botulinum toxin production in 1990—were removed from the facility and destroyed at Al Hakam in 1996.

Other facilities at Al Kindi VVDP Facility and ASVI recovered and made modest improvement in production capability as did Samarra Drug Industries (SDI). During this time frame two new organizations—Al Razi Institute and Ibn-al-Baytar—were established in converted facilities. These organizations obtained highly qualified expertise, some of which were associated with the Iraqi BW program including Dr. Hazim 'Ali, who headed Iraq's viral BW effort and was named Director of Al Razi Institute.

***Beyond its important fixed facilities, Iraq also possessed important relocatable assets associated with its BW production efforts. The destruction in May-June 1996 of the facilities and equipment involved in Iraq's BW program, including the equipment that had been moved or installed at Al Hakam post 1991, significantly altered Iraq's dual-use capability, but did not eliminate all such capability.***

At the Al Dawrah FMDV Plant, one 2,600-liter, two 3,500-liter, and one 236-liter fermentor as well as one 2,550-liter mobile tank were not destroyed under UN supervision in June 1996. These fermentors and tanks were not identified in 1995/96 by UNSCOM as involved in Iraq's BW program. However, DNA evidence of *B. anthracis* was found in both 2,550-liter tanks and a 141-liter fermentor in 1996. All of these fermentors and tanks could be transferred from the FMDV facility to another site or sites within a few weeks after the decision to do so. ISG assesses these as relocatable production assets.

In 1990, Iraq produced at least 39—possibly as many as 70—1,000-liter mobile tanks that could be readily converted into fermentors. Additionally, 8 mobile 800-liter tanks/fermentors were transferred from Al Kindi Vet Vaccine Facility to Al Hakam in 1987/88. Of the combined 1,000-liter and 800-liter mobile tanks, only 24 were cited as destroyed by Iraq. Evidence of such destruction of 24 units was provided to UNSCOM and stored at the UN Headquarters in the Canal Hotel. Thus, 23 remained after the alleged unilateral destruction of BW weapons and agents by Iraq in 1991. ISG has determined that two more tanks were destroyed at Al 'Aziziyah. Of those remaining, four are 800-liter imported tanks/fermentors.

- Rihab stated that Iraq was able to produce one cubic meter model fermentors “with bad wheels”. Documentary evidence dated September 2000 recovered by ISG indicates that Iraq converted one cubic meter storage tanks into fermentors that are assessed to have been indigenously fabricated for Al Hakam under Rihab's supervision. These storage tanks have been an unresolved issue for the UN. Rihab denied receiving mobile tanks/fermentors while at Al Hakam in 1994.
- ISG obtained a document that indicated 10 one cubic meter tanks were connected prior to 2000 to form a 10 cubic meter fermentation plant (location unknown). Another document indicates the delivery of an additional 13-14 such tanks in 1993.

A spray dryer—the second of two air freighted into Baghdad in 1989, model number 0142 was located in 1997 by UNSCOM in a warehouse in northern Iraq, the first model 0141 was at Al Hakam in 1991 and was destroyed in 1996. Before the two weeks it took to assemble a sampling team, Iraq again relocated the dryer, completely disassembled it to cleanse and sterilize it and then reassembled it. This dryer was under monitoring until 15 December 1998 by UNSCOM. Its present whereabouts is unknown.

***ISG judges that after 1996, Iraq maintained—and tried to improve where possible—a smaller, but capable, “legitimate” fermentation capability at agricultural and educational sites that could have been used to produce smaller, yet significant quantities of BW agent, but ISG has found no direct evidence to substantiate this possibility.***

### **Break-Out Production Capability Pre-OIF**

***ISG judges that a break-out production capability existed at one site, the State Company for Drug Industries and Medical Appliances, SDI, at Samarra. Since Iraq could relocate production assets such as fermentors, other sites with basic utilities could also be converted for break-out. A full program to include R&D and production or even just large scale production would require months rather than weeks to re-initiate in a break-out context.***

A break-out of large-scale proportion would require all three key production elements; fermentor capacity, media capacity, and technical expertise. A break-out capability must also take into consideration the scale and scope of the program being considered. Modest or small-scale break-outs would be easier and require less time after a decision to do so was made. For a larger scale and scope such as Iraq possessed in 1990 would require more equipment, larger supply source, more personnel and a longer time period for effective start-up. Iraq, having had achieved a maturing program, had a core group of experienced personnel; a better start than existed in 1985. Personnel are movable assets as is growth media. While sanctions and inspections may be a hindrance to an ample supply of media, it would not have been a show stopper. Iraq developed a milk and corn byproduct media that is judged to be adequate for the production of anthrax spores, albeit of a reduced production efficiency. Thus, the equipment for the scale and scope of a program becomes the critical factor to evaluate a breakout capability.

ISG assesses the SDI to have the fixed assets that could be converted for BW agent production within four to five weeks after the

decision to do so, including utilities, personnel with know-how, and the equipment (with slight modifications) required. Media and additional less-skilled personnel could be obtained (see [Figure 10](#)).

ISG judges the movable assets at the Al Dawrah FMDV Plant could provide the core of an alternative break-out capability at any other suitable site in Iraq, perhaps within 2 to 3 weeks after the decision to do so. The 1 cubic meter tanks or fermentors presently unaccounted for are other important assets that, if indeed still exist, could, when combined with the Al Dawrah FMDV assets, exceed the capacity Iraq possessed in 1990. In this case media and personnel are also movable assets.

- Iraq had shown the ability to move fermentor assets pre-1990 era. Iraq had also shown its ability to utilize small cadres of skilled personnel to lead clusters of less skilled personnel in the production process.
- Iraq gained additional production and development know-how during the post-1991 era.
- Iraq has developed the capacity to produce indigenously, substitute media for the production of some agents, such as corn and milk byproduct media for anthrax spores.

***ISG judges that *Bacillus anthracis* (anthrax) would likely be the agent of choice for breakout production.***

- It represented the single strategic BW agent that Iraq had in its historical arsenal.
- Iraq has a previous track record in large-scale growth, processing, testing and weaponization of anthrax spores.
- Corn byproduct medium, indigenously manufactured for Bt production, would also be suitable for the growth of *B. anthracis*.

### **Mobile Assets**

Prior to OIF, a key source reported that Iraq had developed a mobile BW capability designed to evade UN inspectors and to provide Baghdad the ability to produce BW agents for offensive purposes (see [Figure 11](#)). According to the US Intelligence Community, this reporting was augmented by reports from at least three additional sources who indicated a mobile BW or fermentation capability existed in Iraq. The reported development of a mobile BW agent production capability was a central element in the pre-war assessment of Iraq's WMD programs and, as a result, has been one of the key issues addressed by ISG.

Regarding the mobile capability, ISG's BW team has focused primarily on following leads from the key source and the others with indirect or direct access to Iraq's BW activities to bring us closer to an assessment as to whether Iraq did indeed pursue an undeclared mobile BW agent production capability. The ISG effort consisted of debriefing over sixty individuals and exploiting numerous sites identified as related to a transportable BW production effort. However, ISG acknowledges that much of the site exploitation effort was hampered by Iraqi post-OIF activities such as turnover of employees and looting. Based on information collected by ISG, the key source was determined to be unreliable.

- Debriefings and site visits have uncovered information that differs with pre-OIF reporting, including denials of the existence of the program from personnel allegedly involved. ISG has exhausted many leads and exploited many sites reportedly pertaining to Iraq's alleged mobile BW agent production capability and have obtained no additional evidence to corroborate the claim of the existence of a mobile BW program. As for other individuals that alleged the existence of a mobile BW capability, ISG has not been able to corroborate this reporting and believe that these individuals are outside of Iraq.

***ISG cannot disprove the existence of Iraqi transportable fermentation systems that could have been used for BW, but ISG uncovered no evidence that there were such systems. A report covering the detailed investigations of ISG is attached as Annex 3.***

As part of its investigation into a possible Iraqi mobile BW agent production program, two mobile trailers that were recovered near Irbil and Mosul in 2003 have been examined by ISG. These trailers had tanks or suspected fermentors on board and were initially suspected to be part of a mobile BW agent production program. ISG judges that its Iraqi makers almost certainly designed and built the equipment exclusively for the generation of hydrogen. ISG judges that it is impractical to use the equipment for the production and weaponization of BW agent, and cannot therefore be part of any BW program. A report covering the detailed investigation of the trailers by ISG, is attached as Annex 4.

- ISG has found no evidence to support the view that the trailers were used, or intended to be used, for the production of BW agents, or the filling of BW weapons.
- The design of the equipment makes it unsuitable for the production of BW agent and impractical as part of a BW weapons production system.
- The information gathered, and the assessment of the equipment on the trailers, are consistent with the theory that Iraq developed the trailers for hydrogen gas production.

These findings reflect the assessment solely of the two specific mobile units that were located, and do not necessarily mean that such a capability or intent did not exist.