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Dany Shoham*

Pakistan is a state party to the Biological Weapons Convention, yet at least part of its related outward conduct is rather exhibitory, aiming to foster the image of an obedient, sheer science- and protection-oriented profile. Although it is publicly accentuated that an ongoing Pakistani biological weapons (BW) programme cannot be proved, it is fairly clear that some Western intelligence agencies possess classified information that is highly supportive of such an active programme taking place in actuality. The biotechnological and biomedical infrastructures of Pakistan evidently enable such programme. An active BW programme in all likelihood commenced in Pakistan in the 1980s, and it possibly yielded a first generation BW arsenal by 1994. Otherwise, a first generation BW arsenal probably came into being during the second half of the 1990s or the first half of the 2000s. Ongoing development and upgrading have been observed, underlying a significant Pakistani sub-nuclear weapon of mass destruction capability.

Introduction

Biological weapons are distinguishable for outlining four fundamental dualities. The first is that the borderline ostensibly separating civilian-oriented and military-oriented biotechnologies/purposes is often invisible, and rather does not exist. The second one similarly applies, militarily, to defensive and offensive purposes. A third duality pertains to the strategic importance of BW possession for a country with an

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unfavourable geopolitical and/or military position, which does not possess nuclear weapons (NW), hence, the need to rely on sub-nuclear weapons of mass destruction (WMD); or conversely, it does possess NW, and might feel more confident to maintain and employ BW, already having the nuclear backup. The fourth duality is in that—albeit shaped in the form of weapons—pathogens can be employed in a manner that would outwardly fully emulate a natural outbreak of an infectious disease, leaving the afflicted incapable of proving whether and by whom they were attacked.

Possessing NW capability since the 1980s, Pakistan is plausibly inclined to pursue sub-nuclear WMD too, which is (presently and in the past) the case with most countries armed with NW. In general, such inclination makes sense conceptually as well, as mentioned above, either regarding a state in or not in possession of NW, due to an unfavourable geopolitical and/or military position. Moreover, it is nearly self-evident that a country that succeeded in domestically developing operational NW—whether with or without foreign assistance—would be capable, in terms of technological capacities, to successfully develop operational BW too. All this would apply to Pakistan.

Westwards, the Pakistani perspective and interfaces pertaining to the Moslem block are of relevance as well. For long, already, Pakistan is in that sense an additional sister link, alongside with Egypt (the first one to run BW and chemical weapons [CW] programmes since the 1960s), Syria (irrespective of the chemical disarmament now taking place in that country), Iran and Sudan. During the 1980s—when BW and CW programmes were apparently launched by Pakistan—Iraq and Libya were in a similar position, namely, endeavouring to construct capabilities of CW, BW and NW altogether. Eastwards, however, the Pakistani interfaces with India and China are no less significant, obviously, within that context at large.

Collectively then, the resultant working hypothesis of this article is that Pakistan indeed launched a BW programme and has been implementing it. Various factual and analytical components, as herewith presented, support and corroborate this working hypothesis, although readers should keep in mind that Pakistan is a party to the 1972 Biological Weapons and Toxin Convention (BWC). The information covered for that purpose in the present study pertains to strategic, scientific and technological aspects altogether.

Pakistan's Attitude towards the BWC

Pakistan signed the BWC in 1972—the year it was established—and two years later ratified it. At that temporal phase, Pakistan was not yet involved practically within the BW sphere. Much later, however, and for a long period of time, Pakistan has unwillingly been at the forefront of the BWC negotiations, mainly due to maintaining interfaces with terror organizations that pursue WMD.[1] As a result, Pakistan's conducts within the various forums of the BWC included an impressive range of statements and postures which, in themselves, would ostensibly remove any suspicion about concomitantly running a BW programme.

This distinctive profile has been taking shape since the Fourth BWC Review Conference of 1996, shortly after Pakistan carried out its First National Seminar on Defence against Chemical and Biological Weapons in 1995,[2] and not too long after being pointed at as a country running a productive BW programme.[3] That profile initially relied (in 1996) on a theological motive:

> Islamic laws of war forbid the use of poisonous weapons. For Pakistan, the 1925 Geneva Protocol and the Biological and Toxin Weapons Convention is a manifestation of a moral and cultural ethos that is over 1400 years old. Violations of the prohibition against the production or use of poisonous weapons should be treated with equal determination in all cases, without selectivity or discrimination.[4]

Since the 2001 Fifth BWC Review Conference onwards, different elements were included in the Pakistani statements and postures; it would be worthwhile to mention the following:[5]

1. With reference to Pakistani capabilities and facilities:

   > We have a growing academic and research infrastructure. We have a large pool of scientists who are doing important work in the application of biotechnology in the fields of heath, agriculture and food processing. Pakistan's National Institute for Biotechnology and Genetic Engineering (NIGEBE); Centre for Advanced Molecular Biology; and the Nuclear Institute for Agriculture and Biology, are pioneer institutions for research in medicine and agriculture.
   >
   > Interestingly, the three above-mentioned Pakistani facilities represent two out of the four biological entities sanctioned in 1998 by the United States (US) (while the other two became non-existent, seemingly, as detailed later), plus a third facility

which is affiliated with the Pakistan Atomic Energy Commission (PAEC).

2. With reference to the Chinese proposals regarding the subject of technical and scientific cooperation:

   This Conference must consider the subject of technical and scientific cooperation thoroughly, reaffirming the importance of full implementation of Article X. In this regard, the Chinese proposals, contained in document BWC/Ad Hoc Group/ WP.453, dated May 8, 2001, provide a solid basis for evolving suitable recommendations.

3. With reference to the general status of the convention and its implementation:

   Pakistan is fully committed to the obligations under the BWC. Pakistan has made significant progress in biotechnology. The BWC is a key disarmament treaty that underpins the international security architecture. It should become a framework for cooperation among nations to eliminate biological weaponization and to fight bio-terrorism.

   The Implementation Support Unit will harness resources, force connections, develop networks and identify opportunities… It will make an important and innovative contribution to our collective effort to reduce the terrible threat posed by biological weapons.

4. With reference to dual use of biological resources:

   Rapid developments in the life sciences and life-enhancing breakthroughs in biotechnology have opened new horizons in medicine, health, agriculture, industry and commerce. These advances are creating opportunities to promote applications of scientific discoveries for peaceful purposes under Article X.

   We should agree on measures for enhanced international cooperation in peaceful biotechnological activities. This would facilitate economic and social development and strengthen implementation of the Convention.

   Developments in the life sciences also have the potential of creating new tools of warfare. The BWC regime needs to control the potentially destructive use of such technologies. Security and oversight of pathogens and mechanisms for disease surveillance and response are urgently required. We need to maintain a balance

between negative applications of biosciences and development of technology for peaceful and legitimate purposes. The scientific community is a key player in reducing the risks of the dual-use potential of various technologies. Codes of conduct should aim at preserving the benign uses and stemming the malign uses of biosciences.

5. With reference to the balance between biosafety plus biosecurity and scientific development in biotechnology and genetic engineering:

   Pakistan strongly believes that concrete and effective measures should be taken to strengthen biosafety and biosecurity, but at the same time these measures should not hamper the scientific development in biotechnology and genetic engineering.

   Dealing with the safety and security of biological resources, as well as ensuring that all those involved in relevant activities are aware of the international, regional and national measures which regulate their activities and the principles that underpin them, will go a long way towards ensuring that we continue to enjoy the benefits of biotechnology while being shielded from its dangers.

   The position of Pakistan in regard to the topics being considered is as follows:

   - Biosafety and biosecurity are not limited to physical security of laboratories, pathogens and toxins. They encompass risk awareness, measures to ensure that life sciences are committed to their benign use, and protection of knowhow and technology against bioterrorism and biological warfare.
   - A reliable biosafety–biosecurity system would have the elements of preparedness and response in the event of deliberate or accidental releases, and an effective disease surveillance mechanism at the national, regional and international levels.

Two notable documents submitted by Pakistan to the BWC forums, in addition, are:

1. Perspective on Oversight, Codes of Conduct, Education and Awareness Raising [WP.5]
2. Results of activities to promote universalization of the BWC undertaken by the Chairman and the Implementation Support Unit (ISU) (report)

In a statement to the BWC Review Conference of 2011, Pakistan announced that it had drafted a single law that would 'comprehensively prohibit designing, development, manufacturing, stockpiling, transport, import, export, sale, acquisition and possession of biological agents and toxins including their means of delivery.'[6] Overall, during the various BWC review conferences, Pakistani representatives have urged more robust participation from state signatories, invited new states to join the treaty and, as part of the Non-Aligned Movement, argued in favour of guaranteeing states' rights to engage in peaceful exchanges of biological and toxin materials for scientific research. Unsurprisingly, at least part of the Pakistani conduct is rather exhibitory, aiming to foster the image of sheer science and a protection-oriented profile. Connectedly, it has been observed:

> Whilst such steps are encouraging and commendable, it is not clear the extent to which proclamations have manifest in practice, and Pakistan's unique geostrategic context necessitates that such measures need to be effectively implemented, enforced, and adequately resourced in terms of both political will and economic resources.[7]

Domestic Approaches and Conducts

Mechanisms, Preparedness and Outlooks

The National Command Authority (NCA) of Pakistan is the apex civilian-led command that oversees the policy formulation, exercises, deployment, employment, research and development, and operational command and control of the state's strategic forces, including nuclear and presumably sub-nuclear WMD, plus defence against those weapons. The NCA is responsible for control over all related strategic organizations and systems. The Prime Minister (PM) is a Chairman of the NCA, with all components of NCA, military assets and strategic commands directly reporting to the Chairman of their course of development and deployment. The NCA consists of an Employment Control Committee and a Development Control Committee, as well as the Strategic Plans Division (SPD), which acts as its Secretariat. Among the NCA members are the Director-General of Strategic Planning Directorate (within the SPD), the Minister of Science and Technology and the Chairman of Joint Chiefs of Staff Committee. The latter committee is the highest military body for considering all problems bearing on the military aspects of national defence and rendering professional military advice thereon; it

is mainly responsible for preparing joint strategic plans and providing strategic direction. In addition, the PAEC is part of the NCA. The PAEC is the largest science and technology organization of the country, both in terms of scientific/technical manpower and the scope of its activities.[8]

Within the PAEC, there is a Biosciences Division (also named as the Agriculture and Biotechnology Division), which controls several institutes dealing, among other things, with various pathogens. It can be assumed that this division influences Pakistan's concept regarding BW. Thus the administrative core components involved in shaping the concept and capabilities of Pakistan in the field of biological warfare would appear to include:

1. The Strategic Plans Division (within the NCA)
2. The Development Control Committee (within the NCA)
3. Pakistan Atomic Energy Commission (PAEC)
4. The Bioscience Division (within PAEC)
5. Defence Science and Technology Organization
6. The Directorate of Scientific and Technical Cooperation, Ministry of Defence
7. The Joint Chiefs of Staff Committee
8. Army Medical Corps
9. Ministry of Science and Technology

In practice, it was in April 1995 that Pakistan hosted the First National Seminar on Defence against Biological (and Chemical) Weapons in Karachi. It was organized by the Defence Science and Technology Organization and opened by the then Defence Minister, Aftab Shabaan Mirani.[9] Taking place shortly after Pakistan was pointed at as a country running a productive BW programme,[10] this conduct could reflect a Pakistani countermeasure aiming to exhibit, outwardly, adherence to a sheer defensive programme.

In September 2001, however, Pakistan did conduct defensive preparations, subsequent to the 9/11 and the concomitant anthrax envelope sabotage acts in the US:

> Scientists and doctors in Pakistan are preparing contingency plans to respond to the threat of biological and other unconventional weapons that could emerge as a result of the crisis in Afghanistan, officials said. As part of the plans, hospital authorities are arranging for extra beds and medicines and are training doctors and paramedical staff in ways to cope in case terrorists unleash such weapons in Pakistan

> in response to an expected U.S. attack on neighboring Afghanistan. It was thereby noted that Pakistan's two defense laboratories—one in Karachi and the other in Islamabad—were working to prepare enough vaccines to combat anthrax and other biological agents. Pakistan urged the World Health Organization to help Pakistan with technological assistance in preparing a defense against biological weapons.[11]

Notably, one of the steps mentioned was preparing human vaccine against anthrax.

An allegation made by Pakistan accused India of using agroterrorism tactics in 2002 when India offered wheat to Afghanistan. Islamabad claimed that the wheat was infested with seeds of parasitic plants and fungal diseases such as Karnal Bunt, which could affect wheat production. The Government of Pakistan blocked the transportation of grains across its territory since it could harm Pakistani wheat.[12] Elsewhere, India is mentioned by a Pakistani author, described as 'a career foreign service officer of Pakistan', as follows: 'The Defense Research and Development Establishment at Gwalior is reportedly working on countering disease threats such as anthrax, brucellosis, cholera, plague, smallpox, viral hemorrhage fever, and botulism.'[13]

Reportedly, Pakistan asserted that it is not inclined to produce BW due to the costs involved and the fact that a nuclear weapon state need not go back to outdated techniques and methods of warfare.[14] Such a Pakistani posture ought to be doubted considering a variety of contrasting signs; and that the Pakistani national strategic doctrine at large has been and is considerably affected by the military, both before and after a civilian government was established in 2008.

Connectedly, several review articles published in Pakistan on BW are mostly in favour, technically, of the usefulness and utility of BW, although there is no indication as to whether or not they reflect a crystallized strategic Pakistani approach. The ultimate biological warfare agents (BWAs) mentioned in an article[15] are listed below, in decreasing military usability: smallpox; anthrax; plague; tularemia; botulinum; ricin; gas gangrene; Crimean–Congo haemorrhagic fever; Rift Valley fever; Lassa fever; Ebola haemorrhagic fever; and Marburg disease.

Notably, some of the mentioned pathogens, namely, anthrax, botulinum, gas gangrene and Crimean–Congo haemorrhagic fever, are included within the activities of various facilities in Pakistan. The article concludes: 'We know that biological pathogens have been used for

biological warfare and terrorism, and their potential for future use is a major concern. Therefore, we must be prepared to respond appropriately if they are used again.'[16]

Q fever, a typical BWA, not mentioned earlier, has been elsewhere observed though (in another Pakistani article), to be

> featured regularly on various threat lists, as it may be considered to be used as a bio-weapon. Therefore, we reviewed the literatures on Q fever to highlight the epidemiologic, economic and public health impact of Q fever as a basis for designing effective control strategies.[17]

A third article on BW was published by the Abbottabad Military Hospital in 2004.[18] Three years after the 9/11 and anthrax sabotage took place in the US, and roughly around the time when the compound occupied by Osama Bin Laden was built in Abbottabad, this article presented a noticeable picture concerning BW. It should be noted that no connection was found between the Abbottabad Military Hospital and the al-Qaeda. Some paragraphs of the review article are worth citing:

> According to Dr. Akhter (Mohammad, a very senior American public health figure, originally a Pakistani), the use of biological agents as weapons of mass destruction is no more imaginative, rather it is real. And it is asserted that biological weapons are more destructive and cheaper to produce than chemical weapons, and can certainly be as devastating as nuclear weapons. Unlike chemical agents, which typically lead to violent disease syndromes within minutes at the site of exposure, diseases resulting from biological agents have incubation periods of days; thus delaying the correct diagnosis and appropriate management.
>
> A biological weapon is a device used to intentionally cause disease through dissemination of bacteria, virus or microbial toxin. Depending on the microbe or toxin, resulting disease may or may not be contagious. Biological terrorism, then, is the use of a biological weapon against civilian populations for purposes of creating terror. Generally, the result of use of a biological weapon is an epidemic. The microbial agents required to make some of the biological weapons are widely available, and associated technology is also obtainable, given its legitimate use for agricultural, pharmaceutical or other purposes. Although food, water or insects are potential vehicles for transmission of biological weapons, aerosol dissemination has greatest capacity to cause the disease.
>
> According to Dr. Gould, approximately 70 different types of germs

> can be weaponized for use as agents of biological warfare. The term 'weaponized' refers to packaging or treating an agent so that it becomes easier to distribute to a large area. Potential biological agents include Anthrax, Smallpox, Plague, Botulism, Tularemia, Brucellosis, Viral encephalitis, Staphylococcal enterotoxin B, Viral Hemorrhagic fever (Ebola and Lassa fever viruses), and Q fever.[19]

Skipping anthrax because 'in recent times there has been lot of awareness about anthrax as an agent of biological warfare', the cited article does provide a detailed review about smallpox, plague, tularemia and botulinum as BWAs. However, earlier in 2001, a comprehensive article on anthrax was published by the Combined Military Hospital, Rawalpindi, together with the Pakistan Air Force Hospital, Islamabad, titled 'Anthrax—An Overview in Recent Scenario'.[20]

Handling the Issues of Bioterrorism, Biosecurity and Biosafety

It is fairly evident that collaborative interfaces indeed took place between Pakistani scientists and the al-Qaeda, with the aim of obtaining and weaponizing at least anthrax germs and ricin toxin. Yet, it is unclear whether any of those interfaces was known to any Pakistani at the level of a minister while happening in actuality. Those interfaces formed apparently in the late 1990s and continued into the 2000s.[21]

The anthrax envelopes sabotage in the US in September 2001 followed the al-Qaeda 9/11 terror operation and has, in fact, not been deciphered, although in 2008, the Federal Bureau of Investigation (FBI) concluded, ostensibly, that the perpetrator was an American scientist. At any rate, from 2001 to 2008—if not later—the main suspect was al-Qaeda, though it did not have the biotechnological capacity and hence would have needed extraneous professional assistance. Such assistance, if it was lent to al-Qaeda, could originate from Moslem states or Moslem fanatic scientists.

Pakistani authorities indeed took several concrete steps—procedurally at the least—so as to meet the obligations to strengthen controls over sensitive materials and technologies, as set out under United Nations Security Council Resolution 1540. Thus, in September 2004, Pakistan adopted a legislation—the Export Control on Goods, Technologies, Materials and Equipment Related to Biological (and nuclear) Weapons and Their Delivery Systems Act. This Export Control Act was 'to provide for export control on goods, technologies, material and equipment related to nuclear and biological weapons and their delivery systems.'[22] The Act

has a rigorous mechanism to criminalize and prosecute the individuals and non-state actors involved in the illicit transport of technologies. In addition, in October 2005, Pakistan issued fresh lists of technologies and materials related to the biological (and nuclear) weapons that will be subjected to an intrusive export control system.[23]

A comprehensive National Control List (NCL) of various controlled items, based on the Australia Group and further international systems and lists, was issued after a long process (over four years).[24] The NCL can be reviewed and revised at regular intervals or updated and notified accordingly. Pakistan also established the Strategic Export Control Division in 2007, under the Ministry of Foreign Affairs, which would also have an Oversight Board that would independently supervise, tentatively, the implementation of the Export Control Act of 2004 and the other laws/legislations relating to the illicit trafficking and export control mechanisms. Notably, a special body—the 'National Task Force on Biosafety', within the Ministry of Foreign Affairs—was established as well, aiming, in accordance with its title, to consolidate the international image of Pakistan as an obedient state in whatever sense concerned with biotechnologies and pathogens.

Since the mid-2000s, Pakistan has increased its regulation of the biological industry, issuing a set of biosafety rules in 2005 which established a National Biosafety Committee to create guidelines, issue export licences and inspect facilities dealing with 'living modified organisms or genetically modified organisms'.[25] Also, an updated control list, released in 2011, brought Pakistan's biological export controls in line with those of the Australia Group.[26]

The year 2011 marked two Pakistani articles on biosafety and biosecurity in Pakistan, delivered from the Armed Forces Institute of Pathology and the National Commission on Biotechnology, Ministry of Science and Technology. The two articles emphasize the various actions taken by Pakistan, compatibly with bio-risk managements. The article provided by the Armed Forces Institute of Pathology[27] is more informative then the other one[28] and contains details about: the National Biosafety Committee; the National Core Group in Life Sciences; and the Biological Safety Association.

Interestingly, the second article, albeit less informative, adds to the list two universities: Aga Khan University; and Quaid-i-Azam University. The two universities are thereby mentioned within the context of developing a National Biosafety Centre and an operating project that includes the

elements of bioethics, biosecurity and dual use, namely, 'Engagement and Awareness Raising on Bioethics, Biosecurity and Dual-Use Education Project 2011–2012'.

Noticeably, in February 2012, the Pakistani PM reportedly received a postal package containing anthrax spores (details in the next section). The event certainly amplified an ongoing Pakistani effort taking place for about a decade already, in the related fields of bio-preparedness, biosecurity and biosafety, altogether. Although there is such a genuine effort in Pakistan, at the same time, it considerably serves for strengthening a Pakistani façade—that of a country that is fully committed and entirely follows in reality its undertakings in those respects as well as in tangential respects related to the BWC, ostensibly. However, practically, it also facilitates the acquisition of biohazard instrumentation that can support, technically, BW development and production taking place in parallel within certain Pakistani installations.

Bio-protection-related Facilities

Pakistan Council of Scientific and Industrial Research

Affiliated with the Ministry of Science and Technology, this Council reportedly received from the Pakistani PM's office the anthrax-containing parcel sent to the Pakistani PM in 2012 in order to look into it.[29] Another report noted that the parcel had been submitted to this Council by an unidentified intelligence agency, and then sent to a facility in Lahore for scientific analysis. It was reported that 'The laboratory tests have proven presence of anthrax spores in the parcel and it has been handed over to the agency with results.'[30]

A facility located in Lahore is the Council's Food and Biotechnology Research Centre, which has a bacteriological laboratory. The latter holds regular pathogenic bacteria, including Salmonella typhi, multi-drug-resistant Pseudomonas aeruginosa and enterohaemorrhagic Escherichia coli.[31] Two additional facilities affiliated with the Council are located elsewhere: the Environmental Analytical Laboratory in Islamabad[32] and the Pharmaceutical Research Centre in Karachi.[33]

Considering that the identification of the anthrax germs contained in the parcel sent to the Pakistani PM took place in a facility of the Council, it would appear as if it is the Council which has such national responsibility. Beyond that, however, no exceptional activities could be traced in the facilities affiliated with the Council.

National Institute of Health

Two hundred thirty suspicious samples were received by the institute from November 2001 to March 2002, and these were analysed for anthrax. Detailed procedures applied by the institute for that specific purpose are presented in an eight-pages paper published in 2004.[34] While the institute has been widely involved in monitoring possible anthrax sabotage, such monitoring was taken care of by the Pakistan Council of Scientific and Industrial Research, later on, in the case of the parcel sent to the Pakistani PM (as detailed above).

In the Biological Production Division of the National Institute of Health, industrial cultivation of the pathogens of typhoid, cholera, Cl. tetani (toxoid) and viral pathogens (rabies, measles) takes place, for manufacturing the respective vaccines.[35]

National Veterinary Institute

In the National Veterinary Institute (Veterinary Research Institute, Lahore), reportedly 18 different bacterial and viral vaccines are produced, mostly unspecified. Details are available concerning vaccines against anthrax and various Clostridia (plus toxoids).[36] A viral vaccine—foot-and-mouth disease (FMD)—has been produced too, and, as of 2008, was reported to be of poor quality; however, in 2008 and 2009, successful development of vaccines against other two viral diseases—ovine rinderpest and highly pathogenic H5N1 avian influenza—took place.[37]

Certainly constituting a cardinal and legitimate component of the Pakistani biomedical infrastructure in general, and bearing distinct (yet unimplemented, as far as could be seen) ability to support BWA production on an industrial scale, those two vaccine-producing institutes— the National Institute of Health and the National Veterinary Institute—apparently have the capacity to handle and store highly virulent pathogens.

Biological Safety Level-3 (BSL-3) Facilities

At the basic biomedical infrastructure level, the situation is that a common human pathogen, the tuberculosis bacterium, which is widely explored in Pakistan, requires a BSL-3 facility. The National Tuberculosis Programme of Pakistan planned the upgrading of five BSL-3 facilities (plus 16 BSL-2), though it is not clear to what extent this programme has been implemented thus far.

Specifically, BSL-3 facilities for handling tuberculosis were reported to exist at the Aga Khan University and the Indus Hospital, Karachi. Two

additional tentative/in effect BSL-3 facilities include: a world-class BSL-3 tuberculosis laboratory as part of the KfW-funded 'Tuberculosis Control Programme in Khyber Pakhtunkhwa' project; and a BSL-3 tuberculosis laboratory in Punjab at Al Razi Healthcare.[38] Further tentative/in effect BSL-3 facilities include: a bioreactor in a modular BSL-3 facility for the industrial production of rabies vaccine in the National Institute of Health;[39] and a BSL-3 facility for handling highly pathogenic avian influenza H5N1 viruses.[40]

A vaccine manufacturing facility of InVitro Vogue Pvt. Ltd. is intended to be 'Pakistan's first state of the art BSL-3 animal vaccine manufacturing facility', and is to be established at the Lahore Biotech Park, located on the Barki Road, Lahore, for the University of Veterinary and Animal Sciences of Lahore.[41]

The equipment and know-how found in the mentioned vaccine production facilities enable, technically, serial production of anthrax, botulinum, Cl. perfringens (bacterium plus toxins), Salmonella, V. cholera, and probably certain viruses, for military purposes. However, there are no indications that such production has thus far been conducted in those facilities. The know-how can be utilized, though, elsewhere in Pakistan. It appears that Pakistan is presently self-competent in terms of meeting its needs up to the level of BSL-3 facilities.

It is of note that, in actuality, there are still gaps between required and in effect biosafety measures in Pakistan, as is, for example, the typical case with tuberculosis, a common pathogen in Pakistan that has to be handled under BSL-3 conditions. Nevertheless, this may indicate, indirectly, that Pakistani labs included in or supporting a BW programme could likely hold and handle in BSL-2 facilities those pathogens that require BSL-3, and in BSL-3 facilities those pathogens that require BSL-4. In such case, even if a BSL-4 facility is not found in Pakistan, most infectious and virulent pathogens might be handled and stored in Pakistan.

Suspected BW Facilities

While it is not clear whether the above-mentioned facilities are involved in a Pakistani BW programme, sanctions were imposed on four other facilities that were suspected to be involved. In 1998, the US imposed sanctions (which were later on lifted, in 2001) on four Pakistani entities on the suspicion that they could be involved in biological (and chemical) weapons activities, namely: (i) the National Institute of Biotechnology and Genetic Engineering (NIBGE), Faisalabad; (ii) the Centre for

Advanced Molecular Biology, Lahore; (iii) Chemical and Biological Weapons Research Institute (at the University of Karachi's Husein Ebrahim Jamal Research Institute of Chemistry); and (iv) Chemical and Biological Warfare Research and Development Laboratory (part of the official Defence Science and Technology Organization).[42]

The third and fourth facilities consequently became non-existent, whereas the first and second still persist.

National Institute for Biotechnology and Genetic Engineering, Faisalabad

Primarily affiliated with the PAEC, the institute contains a Health Biotechnology Division, which specialized, indirectly, on a Clostridium botulinum toxin (botulinolysin), from 1992 until 1998 (and probably later). From 1999 onwards, no more works were published in that field.

A shift to the enteric bacterial pathogens, Salmonella, Shigella, Klebsiella and E. coli, including Shigella toxin, took place (as far as reflected in published works). Genetic factors responsible for virulence, toxinogenicity and broad resistance to drugs were investigated. The enteric viral pathogen, rotavirus, was investigated as well.

Two notable pathogens investigated in another division of the institute—the Environmental Biotechnology Division—were Brucella abortus and FMD virus.[43] In 2007, rinderpest samples (spleen, lungs, liver, lymphoid tissue and occulo-nasal swabs) from cattle and buffalos, collected from 1985–94 and kept at –70°C in the institute, were molecularly diagnosed for rinderpest.[44]

Also, the institute was involved in isolating the highly pathogenic avian influenza virus, H5N1, in Pakistan.[45] It was involved in studying the virulence of the fungal wheat pathogens, Puccinia striiformis[46] and Puccinia triticina[47] as well.

Collectively, the published activities of the institute seem to have changed consequent to the 1998 American sanctions. Besides, originally under the auspices of the PAEC, the affiliation of the institute was changed, reportedly becoming the Pakistan Institute/University of Engineering and Applied Sciences, Nilore, Islamabad.[48] The latter appears to be affiliated with the Pakistan Engineering Council and with the Higher Education Commission of Pakistan.

Certain labs in the NIGEBE probably continue to deal with BWAs, particularly Clostridial toxins plus entero-pathogens, and master applicable know-how regarding any botulinum toxin. Dealing with the

pathogens causing brucellosis, rinderpest, FMD and H5N1 influenza is regarded to be significant as well, in terms of potential BWAs. Notable too is the involvement of the institute in studies on the virulence, under field conditions, of fungal pathogens causing wheat stripe rust and wheat leaf rust, known as potential BWAs.

Centre for Advanced Molecular Biology

Largely diversified scientific activities—of which appreciable portions may potentially relate to BWAs—are identified with the centre:[49]

1. Pox virus—preparation and evaluation of buffalo pox virus vaccine.
2. Pasteurella—usage of Pasteurella mullocida dense culture for vaccine preparation.
3. Bacillus—a variety of aspects regarding Bacillus thuringiensis (basically as bioinsecticide).
4. Plasmid-mediated antibiotic resistance in Shigella and Pseudomonas.
5. Various aspects pertaining to Brucella, Klebsiella, Vibrio cholera and Salmonella.
6. Plasmodium falciparum (combinatorial metabolism).
7. Modification of a malaria vaccine.
8. Cloning of viral genes (hepatitis B virus) into a high expression vector pKk223-3.
9. Bacteriophages.

The centre was founded within the Punjab University by the Ministry of Science and Technology in 1987. It has interfaces with an unaffiliated facility named Institute of Molecular Sciences and Bioinformatics, Lahore as well as with the related Punjab University-affiliated Centre of Excellence in Molecular Biology.[50] One notable work published by the latter is on isolation and genotypic characterization of new hepatitis E viruses.[51]

The remarkable range of pathogens and aspects dealt within the Centre for Advanced Molecular Biology fits its involvement in BW-oriented research, development and production, and may account—at the level of open information, at the least—for the institute being sanctioned.

A considerable part of the BW-oriented work might rely on model pathogens, such as pox virus and Bacillus. Alongside, other pathogens dealt with like Brucella, Klebsiella pneumoniae and Vibrio cholerae are employable as BWAs.

Foreign Intelligence and Academic Assessments

Beyond, and in contrast with, the obedient profile fostered by Pakistan as a state party to the BWC, there are assessments, if not concrete intelligence, which point out the opposite: that Pakistan does run a BW programme and has been doing so for already more than 20 years. Following is a synopsis in that regard.

In a 1992 DIA document released under the Freedom of Information Act, Pakistan is mentioned as a country believed to have launched a BW programme.[52] A study prepared in 1994 for the US Congress on potential military countermeasures against nuclear and chemical–biological weapons proliferation categorized Pakistan with respect to BW as 'probable possessor', while one degree of lower ranking is 'suspected (BW) programme' and the higher (actually the highest) degree is 'possession confirmed' (Russia only).[53]

The same year, Pakistan was mentioned in Germany as a country 'on the point of establishing its own production of BW', according to a quote from a confidential BND report.[54] Two years later, a US Department of Defense report noted that Pakistan was 'conducting research and development with potential biological warfare applications.'[55] As mentioned earlier, in 1998, the US imposed sanctions on four Pakistani entities on the suspicion that they could be involved in biological (and chemical) weapons activities. The Canadian Security Intelligence Service estimated Pakistan to be a country 'of greatest concern from a proliferation perspective', in a report on BW proliferation, issued in 2000.[56]

Beyond being 'active in the area of defensive biological (and chemical) weapons research', as assessed by the German Federal Customs Administration, 'Pakistan's monetary expenditure for its nuclear and missile programmes leaves little scope for it to mount an offensive biological (and chemical) weapon programmes, though this cannot be proved'.[57] Certainly improvable, the latter equation-like observation is at any rate doubtful.

Moreover, it has elsewhere been assessed that Pakistan would likely 'invest in offensive weapons, because its infantry forces are outnumbered five to one and outgunned three to one in tanks and artillery when compared with Indian forces.' Biological (and chemical) weapons might thus be needed, according to the Pakistani concept, since

> nuclear weapons do not help in the numerous smaller conflicts that continue to occur between the two nations. Pakistan may see

> biological (and chemical) weapons as the way to counter the larger Indian forces, much as Iraq held off superior Iranian numbers in their conflict.[58]

Indirectly, yet relevantly, it has further been observed that in case two Third World states become bogged down in attrition warfare, there might be a temptation to use BW against the enemy's front line forces, if only to cause logistic and morale problems.[59] Pakistan might conceivably follow such a line.

Another study, issued by the European Union (EU) Non-Proliferation Consortium, contended that Pakistan would 'on paper, be well placed to produce biological (and chemical) warfare agents', although 'there is no evidence of any active Pakistani programme in the areas of offensive biological (or chemical) warfare.'[60]

Eventually, the US Congress set an action stating: 'US President must make securing biological (and nuclear) materials and weapons in Pakistan a priority. Congress should ensure that sufficient funding is authorized and appropriated for this purpose.'[61]

It is of note that Pakistan has been repeatedly regarded to be one of several countries illegitimately possessing the smallpox virus (which is internationally disallowed, except for the US and Russia). In that connection, from 1970 to 1972, extensive field studies on smallpox outbreaks that occurred in Pakistan took place (some publications are referred to in that respect[62]). It can be assumed, then, that the virus was actually isolated, and in that case, the virus might be held in Pakistan until present.

Conclusions

Collectively, taking into account the above-mentioned observations, there is apparently a sound rationale which led Pakistan to pursue BW and establish a strategic concept in accordance. The various considerations and postulations underlying a presumed Pakistani seeking for BW, as described herein, are regarded to be plausible. It can be concluded that an active BW programme, in all likelihood, commenced in Pakistan in the 1980s. It possibly yielded a first-generation BW arsenal by 1994. Otherwise, a first-generation BW arsenal probably came into being during the second half of the 1990s or the first half of the 2000s.

The timing of the sanctions imposed by the US on the Pakistani biological entities—in 1998—was rather in the wake of Pakistan's May 1998 nuclear tests, when the US Department of Commerce imposed

sanctions on a large number of government and quasi-government entities. However, the case, in terms of an apparent Pakistani active BW programme, was already there.

Although it is publicly accentuated that an ongoing Pakistani BW programme cannot be proved, it is fairly clear that some Western intelligence agencies possess classified information which is highly supportive of such an active programme taking place in actuality. The biotechnological and biomedical infrastructures of Pakistan evidently enable such a programme. Ongoing development and upgrading have been observed connectedly, underlying a significant Pakistani sub-nuclear weapon of mass destruction capability.

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