3.1 EVALUATION OVERVIEW

Roland Waast

The evaluation of the national research system was carried out at the request of the Moroccan Ministry for Scientific Research, with the support of the European Commission. This chapter covers its methods and main results.

Organised by a specialist research team ([1]), it was, in accordance with the ministry's wishes, a resolutely external evaluation, limited to the exact sciences, life sciences, and engineering sciences (i.e. all but the social and human sciences) ([2]).

The *in situ* visits to many Moroccan laboratories by some 20 European experts were a core part of the process. Preparations for these involved painstaking efforts to take stock of current capabilities. The operation lasted a year-and-a-half (in 2002 and 2003) and culminated in a large-scale workshop to hand over the results ([3]).

I shall now outline briefly the tools and results of the preliminary survey, before moving on to the experts' verdict.

1 The Science, Technologie et Société team belonging to Savoirs et Développement research unit of the Institut de Recherche pour le Développement (Institute of Research for Development (IRD)) , France.

2 These will be evaluated later, in light of the results of the operation presented herein.

3 The operation took nearly a year to prepare. The experts' visits were spread over a period of 6 months. Three months were needed to organise the workshop, and prepare its basic documents. This *length of time* served to ensure not only the quality of the work but also the participation and involvement of various stakeholders.

3.1.1 METHOD

The method adopted divided the action into three phases: the preliminary survey, the actual evaluation (i.e. laboratory visits by the experts), and the handover of results in a public workshop.

Phase one (the preliminary survey) set out to produce a body of original, reliable and detailed information that would provide a robust picture of the state of Moroccan research. It hinged on three tools:

- historical backgrounder on Moroccan scientific institutions;
- bibliometric analysis of Moroccan scientific output published over the previous 10 years in the world's 6 000 leading journals;
- questionnaire e-mailed to some three-quarters of all Moroccan laboratories, focusing on the resources of grassroots units, and on their views of the difficulties and drawbacks that need to be removed.

The actual evaluation was done by around 20 European experts selected for their proficiency (academic and applied), experience in management, leadership and evaluation, and the fact that they were in no way involved in any ongoing cooperation with Morocco. They each submitted a report on their respective areas of expertise, and defended its content at the final public meeting.

It was understood that the results would be presented and debated at a national workshop on the Moroccan research system. The ministry that organised the event wanted it to be a large-scale gathering with wide-ranging discussions. All of the various stakeholders (e.g. responsible ministries, producers and users) were involved. The experts' reports, made available in full and defended by their authors, provided a basis for two days of substantial, lively debate. Those documents, later compiled by the ministry into an extensive three-volume work ([4]), form a robust frame of reference that continues to inspire analysis and action today.

3.1.2 STATE OF EXISTING CAPABILITIES

At the risk of repeating some of the points made in previous chapters, I shall now recap on the nature and main results of the tools used to take stock of existing capabilities.

- ***The institutional, historical backgrounder***

The institutional backgrounder included a *catalogue raisonné* of the establishments with research facilities, providing details on staff, assignments and activities. It showed how those parameters had changed over the years. At the national level, it examined research budgets, legislation and the governing bodies, and stated priorities.

The historical perspective embossed the overview. The main points that it brought to light are detailed below.

It was in setting up a junior minister's office for research in 1998 that Morocco demonstrated its desire to provide itself with policy in this area. Previously, though, research had continued to develop 'unprompted' in specific places and for specific reasons, as follows.

- First, development began at the universities, where teachers seeking promotion needed to present a succession of theses ([5]). This means of regulating the profession had a major impact from the 1980s onwards with the extension of access to university to an ever-wider public, and large numbers of people embarking on a career in teaching.

- Development took place within 'management and professional training' schools, operating outside the university system, which made their mark for their applied research capacities. They were set up and governed by various ministries to tackle the shortcomings of the university syllabus in some engineering and technical areas. They

[4] Department of Research, *Atelier National sur l'évaluation du Système de la Recherche Scientifique dans les Domaines des Sciences Exactes, Sciences de la Vie et Sciences de l'Ingénieur, Rabat, 26-27 Mai 2003, Rapport d'évaluation*, 3 volumes, MESFCRS: Rabat.

[5] 'Diploma-based' promotion and recruitment was part of the status of teachers, which had been reformed in 1975 with the increase in staff numbers. It was no more than a matter of career management. No particular thesis themes were prioritised, and no funding was provided. Individuals had to do their work or strive to forge relationships with well-equipped foreign laboratories off their own bat. Scientific cooperation, formal or otherwise, would be the only form of research policy for quite some time to come.

were selective and highly supervised. After a tentative start in the late 1960s, they came to be established as a model and proliferated in the second half of the 1970s ([6]).

- It also occurred in offices and agencies with a partial commitment to conducting surveys and research. They had long operated, in fits and starts, as 'research institutes' or 'research centres'. They employed full-time staff, and operated under the supervision of the technical ministries, in what the state regarded as its areas of responsibility. These included public works, agriculture, marine affairs, fishing, and public health, and from 1980, nuclear, oil, demography, forestry, and so forth.

- Finally, developed took place within a number of industries (e.g. phosphates and ONA: Omnium Nord Africain), which had developed their own R&D centres or departments; lately, a number of research consultancy have begun to be set up.

So, Moroccan research had been constructed in a composite, and at times unexpected manner. The research system comprised establishments that had emerged at different periods, with differing status and supervising bodies, in response to differing concerns, where research was often regarded as a task of secondary importance.

This historical background accounts for the complexity of the organisational charts. It helps understand the system's internal tensions: between regulatory authorities, sometimes between branches and among staff (due to their unequal status), and between epistemological stances and conceptions of what constitutes worthwhile science ([7]). It also reveals the great scope of recent government initiatives (e.g. coordination mechanisms, national bids for tender, and incentives to encourage researchers to network).

The backgrounder was much appreciated by the experts when they were preparing their assignments. It also served to organise visits to the widest possible variety of establishments. The historical perspective, the extensive bibliography, and the large number of tables and annexes, made it a key source of reference material.

- ***'Bibliometric' backgrounder***

To recall the basic principles, the aim here was to use measurable output as a means of producing a fine-tuned description of Moroccan research. Publishing work, which is normally the goal of every researcher ([8]), represents one such means. Large bibliographic databases record all articles published in a wide range of journals. We selected 2 general-interest databases, covering the best 6 000 journals that included all of our target disciplines, and extracted every article published over a period of 10 years by authors with a declared attachment to an institution in Morocco. We then divided those articles into 100 scientific subfields, and examined their origins by city, institution, year of publication, and author.

This provided an overview of the overall scientific field, capable of serving as a basis for comparisons between different periods and with other countries. The results can be presented from two points of view.

6 The university's main underlying purpose was to train teachers and administrative managers. Not finding this to their advantage, the technical ministries gradually created their own schools to train engineers and marketing people. Staff did not have the same status, remits and supervising authorities as in the national education system. Initially peripheral, this 'sector' later came to be presented as a model and was expanded in the 1970s.

7 Broadly speaking, there are two styles of science: one that is more 'academic' (based mainly at the universities and linked more to academic status), and another that is more 'engineering'-minded (more present at schools and centres, more downstream-oriented, and whose staff, for the time being, lack their own specific status).

8 For more on this point, see the chapter on 'Bibliometrics'.

The first point of view highlights the rapid expansion of Moroccan research (output quadrupled between 1990 and 2001). Such progress — an outstanding achievement by global standards — has enabled the country to establish itself firmly as the third-ranking science producer in Africa ([9]). It has clearly outstripped Nigeria, which once held an apparently unassailable position but has slipped into decline, as well as Kenya and Tunisia ([10]).

Among others, strengths have emerged in the fields of mathematics, nuclear physics, general chemistry, oceanography, marine zoology and marine biology, livestock rearing and veterinary medicine, geology (more than geophysics), some of the engineering sciences (including civil engineering), and metallurgy. Outstanding areas in the field of health include neuropathology, cardiology, medical imaging, and genetics (more than microbiology). More often than not, this data was confirmed by the views of the experts, which was an encouraging sign vis-a-vis the reliability of the bibliometrics (see Part 2. 3 — Detailed bibliometric analysis: methods and outcomes).

The second point of view is the one in which the results described the current situation. They showed that the growth had continued but the pace of expansion had eased ([11]). A transition was on the cards; skills were differentiating and becoming spatially redistributed (see Bibliometric analysis), giving rise to problems of critical mass, shared equipment, and coordination. A pioneering generation was preparing to pass on the torch, raising the issue of the new researchers' model of professionalism and motivation.

The bibliometric data was useful in many ways. It helped assess the number of approximately 4 000 'active' researchers — this was far fewer than the 'theoretical potential' of 16 000 (including all academics), meaning that Moroccan research still had room for improvement — and the number of teams and laboratories producing published work (around 800). They also made it possible, in the absence of any other data on productivity, to choose which sites the experts should visit.

Notwithstanding its obvious limitations — underestimation of output in the applied sciences, delays in recording the work, poor coverage of the few local journals, and so forth — it is a robust, efficient and reliable tool (as confirmed in the experts' reports). It can be updated every year, with minor coding adjustments. It is a good instrument for maintaining a panel of indicators.

- ***Laboratory questionnaire***

A questionnaire was sent to the laboratories by e-mail. It focused on aspects that would otherwise be hard to grasp routinely during the experts' visits; for example, the laboratory's structure, budget, collaborations (national and international), equipment and maintenance, documentation, output, and marketing of results. First and foremost, it would cover the full range (or a representative sample of) laboratories; unlike the visits, which would inevitably end up being selective.

Carefully prepared in terms of its substance and form, the questionnaire was tested thoroughly in advance, and was prepared as a methodological test. What seemed

[9] Unsurprisingly, Morocco remains some way behind South Africa (four times more powerful, and the leader in virtually every field), and Egypt (two to three times more active, especially in engineering sciences).

[10] Followed by Algeria, and then a cluster of around 10 or so smaller scientific countries.

[11] Reasons for this can be found in the experts' reports.

the easiest part of the exercise turned out to be the hardest — finding the e-mail addresses to which to send the file. It became clear that there was no directory of the 'laboratories', due to the lack of any official records of their existence (i.e. no status, no budget and, hence, no activity reports). It was, therefore, necessary to build a directory with the assistance of the ministry. E-mail subsequently proved to have many benefits, making it easier to despatch reminders and, when necessary, requests for further clarification. However, it also required daily follow-up. Although recipients showed a great deal of goodwill in replying, unreliable addresses prevented us from reaching everyone on the list.

With a highly satisfactory reply rate — 500 out of the 800 laboratories identified — the final results were based on a very large sample of research units. They established reliable orders of magnitude, and occasionally the results came as quite a surprise. The main findings are as follows.

- The average size of laboratory staff was around seven or so people. This is not very different from an average-sized 'team' in Europe. What was surprising here, though, was the number of PhD students: two for every four academics, and one engineer.

- Although individual situations varied greatly, laboratory budgets averaged some MAD 16 000 per researcher (PhD students included) annually ([12]). The key point was that the laboratories had clearly begun enjoying an influx of state funding (PARS and PROTARS research support programmes occupying a major place in this area).

- While the private sector and public authorities contributed little in the way of funding ([13]), collaborations with them were far more numerous than expected. Eighty percent of the laboratories were involved in national collaborations, a quarter of them with the private sector, and an equally large number of international collaborations ([14]).

- Almost every laboratory manager regarded their units as being underequipped. Maintenance was a source of concern, together with slow management procedures, and heavy red tape. One major worry revolved around access to 'hot' documentation.

- Articles were published mainly in international journals — and in a mere handful of national ones — with a more or less equal number of papers delivered at conferences.

- The figures here confirmed the bibliometric data. Average 'productivity'— one article every two years — left some room for improvement. Yet output here, as elsewhere, was highly concentrated at times, with one-fifth of the laboratories presenting vastly superior scores.

- There were many different forms of results spreading. Patents were few. Endeavours to meet the socio-economic demand were more informal and direct. The spreading of results hinged on continuing education (provided by half of the laboratories), R&D (with half the laboratories reporting at least one application in the previous five years

[12] Half of the units had an average of MAD 3 000 per researcher annually (MAD 10 was the equivalent of more or less EUR 1 at the time). At the other extreme, a quarter of the laboratories had between 10 and 30 times as much. The extra funds derived from successful tender bids in Morocco or abroad.

[13] In the form of payment for services, studies or R&D instead of research funding provided by supervising authorities.

[14] France was the main partner at the time — in two-thirds of the cases — but the picture has become more diversified, with Spain leading the field, followed by Belgium, Germany, Italy and Canada.

— a claim needing to be checked), and sustained relationships with a number of economic operators (e.g. provision of expertise and collaboration in R&D).

3.1.3 VIEWS OF THE EXPERTS

The actual evaluation was assigned to around 20 European experts, assisted by an equal number of Moroccan experts. This represented the core of the operation. Together, the European experts covered the entire range of disciplines. They were each asked to visit a selection of laboratories, and to report back on their observations in relation to the state and structure of the laboratories, and relevance of the subjects addressed, and the ambitions, questions and plans of the researchers encountered during the on-site meetings.

3.1.3.1 A reminder of the method

I have already talked about the conditions laid down for recruiting the experts (cf. Chapter 1). They needed to be of a high academic level, conversant with application, leaders of experienced teams, and well-established evaluators. And they had to have no current interest in Morocco. I have also recounted how the sites to be visited were selected: on the objective basis of the bibliometric data, upgraded through the addition of major private or applied research institutions ([15]). Heads of institutions had the chance to add particular laboratories to the list of those being visited on their premises; and researchers were under no obligation to take part in the *in situ* meetings.

In practice, the operation was seen as a sign of respect on the part of the government, and of genuine interest on the part of the ministry. This had much to do with the meticulous groundwork and the human qualities of the experts, as well as the duration of the operation; while the visits initially met with a degree of scepticism at times, they were frequent and incisive enough to be taken seriously in the long run. Let us remember that the experts covered some 50 000 kilometres, visiting 13 of the 14 universities, most of the research institutes and engineering schools, and several private and semi-public companies carrying out R&D. Four hundred 'laboratories' were visited, and 1 500 researchers — i.e. an estimated third to a half of the national research capacity — attended the meetings organised on-site.

The method proved perfectly suited to the size of the Moroccan scientific community. The on-site visits by experienced, foreign scientists generated a good deal of interest, and high hopes of the revival and recognition of research, which was one of the community's main expectations.

[15] Establishments that had slipped through the net of the publication-based approach (see chapter on Bibliometrics).

3.1.3.2 The verdict in a nutshell

The European experts then carefully drafted their reports, which were presented at the final workshop. They were neither simplistic nor uncritical. I do not intend to go into the wealth of their content here: they deserve to be read in full ([16]). Instead, I shall confine myself to those comments where opinions tended to converge, albeit with shades of difference in some areas, forming a single overall view rather than a collection of scattered ratings.

The experts regarded *Moroccan research as being at a crossroads*.

On the one hand, the previous 20 years had seen the powerful and continuous expansion of capacity and output. Morocco, as mentioned above, had just established itself as the third-ranking producer of science in Africa. In most disciplines, it now boasts a large number of high-quality researchers who have personally made a name for themselves on the international stage, and many of whom are anxious to serve their country. Furthermore, a highly active, dedicated ministry has, in recent years, taken a good many initiatives; for example, introducing incentive budgets, providing support for networking, launching evaluations, and implementing national tools for assisting research units (such as equipment, computer link-ups, and documentation).

But a research system remains to be structured and linked to innovation.

The investment has been achieved, and it is now a matter of ensuring that it bears fruit by means of wise deployment. This can be done, relatively inexpensively. The following paragraphs highlight some of the details of this assessment.

3.1.3.3 The researchers: a strong point and an Achilles heel

The main strength of Moroccan research lies in the quality of its researchers. Evidence of this can be seen in the long-term growth of scientific output. It is a fact that the experts themselves confirmed and elaborated on, as shown in the details and discipline-specific variations set out in their reports.

The driving force behind that growth was the requirement to produce theses in order to move up the academic ladder. But that driving force has run out of steam. Most applicants are now accredited; research has all but ceased being a precondition for their promotion, and the recruitment of new teachers is no longer a priority (at least not as much as before). Finding new incentives likely to attract PhD students and young researchers, for instance, has become a must.

Unless a new driving force is found, the capital so painstakingly amassed will soon erode. The warning signs are clear to see. Many researchers, after completing their theses, are

[16] Ministère Délégué à la Recherche, *Atelier National sur l'évaluation du système de la recherche scientifique dans les domaines des sciences exactes, sciences de la vie et sciences de l'ingénieur, Rabat, 26-27 mai 2003, rapport d'évaluation*, 3 volumes, Rabat: MESFCRS.

channelling their energies into other — personally more profitable — activities. In some places, no more than one-quarter to one-third of them are estimated to still be working in research. And active teams are in danger of having no choice other than to apply their trade within the framework of a global division of labour, where they occupy the position of subcontractors (e.g. when preparing theses abroad).

Furthermore, capabilities are dispersed among institutions of differing status, whose declared duties, in some cases, do not include research. They are fragmented (due to individual academic research), and sustained by vertical international relations. They neither have the time nor the means to build a national scientific community capable of acting as a regulatory body, organising meetings, providing impetus, and making proposals.

All of this makes it hard for the researchers to choose the best research subjects. Independent access to scientific documentation is not easy. Except when taking part in major international programmes — especially in the fields of science and industry — can researchers perceive the stakes and opportunities (commercial included) linked to the advancement of science. The desire to work on national themes does not always take into account the sound tools necessary for evaluating their relevance, effectiveness and feasibility.

A subject cannot be considered relevant, for instance, just because it has something to do with Morocco. It must tally with a scientifically and economically innovative niche, to give due weight to the advancement of science at both the local and global level, and downstream opportunities.

There have, of course, been some noteworthy successes on that score in Morocco. The experts highlighted and examined these with a view to showing how to build an appropriate strategy for choosing subjects ([17]). But one cannot rely only on the researchers to prepare such strategies on their own. They need the regulatory oversight of a scientific community, they must establish a rapport with the socio-economic environment, and, most importantly, they have to have the guidance and support of the national authorities.

3.1.3.4 Creation of a dedicated ministry and the work it has initiated: a strong point in need of perseverance

Recently, significant progress has been made as far as this latter point is concerned. The creation of a dedicated ministry was a decisive step forward.

The setting up of a specialised Interdepartmental Committee — one of whose first moves was to endorse the external evaluation — has provided a forum for coherent planning, and for distributing tasks. Various kinds of research assignments exist in such fields as water, maritime affairs, agriculture, and health. In regard to the latter, for instance, health issues should be dealt with by the Ministry of Health, while related matters to do with sci-

[17] Ministère Délégué à la Recherche, op.cit., especially the chapters on medicine, physics, chemistry of natural substances, information-communication, and marine sciences.

entific excellence have to be assigned to the Department of Research. Now it is possible to devise cross-disciplinary, national programmes, and a coordinated division of labour.

Significant support has been provided for grassroots units, mainly in the shape of incentive funding schemes such as Scientific Research Support Programme (PARS) and Thematic Scientific Research Support Programme (PROTARS). Researchers have regarded this not just as an injection of support but also as a welcome sign of attention, and they have become enthusiastic players in bidding for tenders.

What is more, it has helped introduce and initiate a culture of evaluation. Previously, the certification of doctoral training programmes had paved the way for this, and given rise to the first efforts to encourage individual academics to work together. Current backing given to 'Centres of Excellence' is furthering such endeavours through support for team networking.

Everybody was talking about the newly established "MARWAN" interuniversity computer network, and the budgeting of research central support units, including the Institut Marocain de l'Information Scientifique et Technique (Institute for Scientific and Technical Information (IMIST)) . The experts noted that active researchers had applauded and fully adhered to these initiatives.

A considerable amount of legislative work had been done. Although less instantly recognisable, it was just as significant at grassroots level. Decrees had been issued on sabbaticals and on duty-free imports of scientific equipment. Efforts were under way to introduce PhD fellowships. And institutional independence was expected to open up a huge field of action.

So, the right work was being done on a good many fronts to overcome the existing handicaps, and to make the most of the national research system.

3.1.3.5 The research system: weak yet changing

Morocco's scientific capital is a godsend. However, the country must take a major step forward in order to reposition itself economically, and to address the inequalities. It needs to develop national expertise, technological imagination, and the capacity to understand and anticipate change. The practice of carrying out 'focused' research (including in basic science) will be extremely helpful.

But scientific capacity alone is not enough. Activity must be organised into a 'system'. What does this mean? Medicine familiarised us with the concept: we know we have a nervous system, a digestive system, a blood circulation system, and so on. Any system is partially independent because it has its own particular purpose. It is comprised of organs, each with a specific role. Those organs are interlinked; when one fails, the overall goal will not be met. The system is coordinated; information flows around it in real time to achieve a set of goals. The system is focused; it has an end purpose, and adjusts itself automatically.

Morocco definitely does have the constituent parts of a research system; for example, institutions engaged in research, coordination tools, equipment and funding, and active researchers with deep-rooted values and practices. Ironically, the underlying difficulty may have been that the purpose had yet to be recognised. It was like having eyes, optic nerves and a brain, for instance, without discovering what they were supposed to be used for (i.e. to see).

Officially, of course, research exists in the remit of universities and dedicated institutes. But it must cease to be seen as a by-product (of the education system), an ancillary (for providing services) or a subcontractor (i.e. taking on foreign subjects), and must be recognised as having a specific role.

Many of the experts drew attention to the need to foster clear awareness of the goals of research, incorporate its goals into a clear plan within the institutions, and equip it with its own regulatory mechanisms. They each, in their respective areas of expertise, made a strong case for doing this.

Some of the reasons they put forward are widely accepted; for example, the need to do research in order to ensure up-to-date teaching. But the universities preparing for self-government could also consider it as a means of securing a seal of approval. The quality of higher education is high throughout the Moroccan public education system. What commands attention — on the part of society at large, customers, students seeking recognisable qualifications, and so on — is the reputation of outstanding successes, and the guarantee of tangible achievements.

The experts also presented other, stronger, reasons for cultivating research. If the purpose of research is taken seriously, it can reasonably be expected, inter alia, to:

- improve optimisation of natural resources management and marketing (e.g. geological research and chemistry);
- create new jobs to replace those being lost (Information and Communication research);
- discover unimagined resources (e.g. undersea and natural substances);
- cut down on expenditure on various imported engineering goods and supplies;
- improve risk monitoring (early warning and prevention systems tailored to oceans, geophysics, urban geology, and so on);
- keep agriculture abreast of new developments (e.g. in plant material and pest control);
- generally speaking, embrace the modern-day struggle to combat recurrent scourges (e.g. deforestation and drought) and future ills (e.g. pollution and diseases), and help build the capacity to master complex systems (e.g. water, agriculture and health) through mathematical modelling, for example.

It is well worth reading the experts' suggestions in regard to imaginative research subjects. A good deal of especially well-focused work was already being done but it was often little-known and underexploited. Instead of dwelling on that particular conundrum, the experts sought to identify the chronic obstacles preventing research from fulfilling its potential.

To their own surprise, they found those obstacles to be much the same in all of their various specialist fields. Low awareness as to the purpose of research had given rise to four rectifiable lines of weakness vis-à-vis certain means, critical mass and evaluation, and relations with society and the world of economics. Their opinion, in a nutshell, was as follows.

In regard to the means, beyond the noteworthy efforts they had observed, the experts drew attention to a number of points that remained to be addressed.

- Equipment: universities lacked the equipment required to be able not only to conduct reasonably ambitious research work but also to offer reliable services to local companies ([18]). In addition to the special funding granted recently to the faculties by the ministry — in a move that deserves to continue — three points had to be addressed: maintenance (e.g. budgeting, dedicated technicians, and a central emergency repair unit), sharing (i.e. platforms for very large-scale equipment), and travel allowances for researchers based in remote places (to be funded within the framework of the platforms).

- Documentation: the key to independent research. Without a doubt, only a national-level solution would suffice with collective subscriptions to the major scientific publishers and electronic dissemination. This could be the first task of IMIST.

- Human resources: it is crucial to attract young researchers (PhD students), and probably useful to consider bonuses for productive researchers.

- Administrative procedures: management and oversight needs call for more suitable rules, even governing such details as the procurement of consumables, revised budget itemisations, and so on. Institutional independence — with project or laboratory-specific book-keeping, if possible — could be extremely helpful.

In regard to critical mass

- In some disciplines, the experts' opinions differed as to the 'right size' of grassroots units. Nevertheless, they agreed that existing teams were too small to carry out programmes measuring up to their capacity; to mobilise the wide-ranging skills required for a particular project ([19]), and to move beyond the realm of subcontracting.

- Most advocated the creation of 'laboratories' that were approved — and, hence, evaluated and funded — on the basis of project proposals.

- Unifying their forces was, in their view, the responsibility of the researchers themselves. The experts recommended incentives for voluntary collaborations. They also

[18] They must be equipped with these two concerns in mind, and with a view to promoting the emergence of 'quality-certified' laboratories. Some faculties have set out to construct research buildings and/or to pool annual appropriations in order to acquire large-scale, shared pieces of equipment. This is a good solution. Other efforts need to be agreed upon by the ministry and by the universities themselves to ensure that they genuinely make the grade.

[19] See, for example, the geological map in the report on the earth sciences.

stressed the need for regular evaluation, strict certification, and efforts to publicise the seals of approval awarded in exchange for guaranteed grassroots support and acknowledgement of the manager's duties (e.g. reducing the teaching load).

- The ministry's action in support of Networks of Excellence and Centres of Excellence was well placed. However, the experts stressed that in several areas more attention must be given to ensure that their programmes and their procurement of equipment paved the way for R&D cooperation within the productive sector.

In regard to scientific evaluation

- This is the heart of the research system. It is a must for all of its actors. It sets benchmarks for actual researchers, is a management tool for decision-makers, and it is a powerful means of raising awareness of — and gaining recognition for — national research in the global scientific world.

- Based on their 'research plan', evaluations must cover institutions, laboratories, and the staff assigned to research duties ([20]). The criteria must be unambiguous, relevant, and plain to see.

- First and foremost, an evaluation is not a judgement but a reflection of reality. It must be endowed with positive sanctions. Serving staff should receive a 'productivity bonus', forms of which remain to be determined (e.g. a meaningful career award, an earnings supplement or an arrangement in terms of working hours and duties). Institutions and laboratories could see their budgets adjusted according to their results.

- A credible evaluation system needs the support of representatives from a structured scientific community. Such structuring cannot be done to order. It can come about only through an internal movement, inside the community itself. But it could be a key policy initiated on the part of the authorities to encourage and facilitate every effort to achieve that end by supporting academies, associations, national journals, and conferences. The authorities themselves need to have competent representatives trusted by their peers at hand to advise them in each major field.

Linked to the evaluation issue is the sensitive matter of the choice of research subjects, as follows.

- The experts recalled the dual purpose of research: the advancement of knowledge, and social utility. Irrespective of the goals pursued, the same two questions were raised: what was its relevance, and was it effective? Only the criteria differed. At one end of the spectrum — basic research — the relevance consisted of the 'hot' fronts of world science, while effectiveness was measured in terms of citation of the work in other publications. At the other end — development and prototypes — the relevance consisted of being close to a local need (or even creating demand), while effectiveness depended on whether the results genuinely were taken on board by a socio-economic operator within a reasonable time frame.

[20] Clearly, the frequent case of staff no longer actively involved in research — and merely providing consulting services, supervising students or preparing a personal thesis — is awkward. In this regard, solutions have been proposed. Indirect (yet verifiable) services to research can be taken into account.

- The choice of subjects requires first-hand knowledge of the advancement of science in the world, and reliable information on the downstream opportunities; for example, markets (local or global), users, and 'buyers'. A good subject was developed on a Moroccan comparative advantage in a promising niche.

- From that point of view, one must be wary of the subcontracting of foreign science. It is, of course, possible to take advantage of it. Morocco needs to remain connected to cutting-edge science, not to reinvent it. But routine and slavish subcontracting must be avoided. An independent strategy needs to be introduced. It is important to know the place it affords in the scientific division of labour, and in the major technological challenges. It is also important to see if it serves merely to sustain a practice or is geared to updating and upscaling — whether it boils down to the consolidation of world science or provides access to it being cutting edge and to the global marketplace.

3.1.3.6 Relations with the productive sector

This is a key section of almost every single field-specific report.

According to the experts, current difficulties between the research and business communities stemmed from the lack of benchmarks on both sides, and from a culture of excessive gratuitousness. In regard to benchmarks, researchers were dispersed and lacked visibility, and the equipment at their disposal did not lend them the credibility they needed to develop partnerships. At the same time, many were unaware of the expectations and demands of potential users. A number of customers doubted whether they had the capacity to do what was necessary to become operational.

However, their services were used within the framework of private consultancies or as a gesture of goodwill; for example, by taking in PhD students, unfunded, whose work would later on serve as reference material. As a matter of fact, awareness of the need for studies was low, even on the part of the public services. Studies were used but it was not customary to pay for them, except in the case of engineering. Nor was it customary for researchers to work for money or on mission-oriented research projects.

Something can be done to remedy such misconceptions. To begin with, plans could be made to grant certain laboratories a seal of approval, and to equip them in such a way as to enhance their credibility. It would be useful to bring a 'strategic assessment of company needs' to the attention of researchers, and to publicise both the seals of approval granted and the successful collaborations.

Meanwhile, effort could be made to establish fairer contract-based relationships, which would call for a specialised unit to assist in negotiating and signing agreements. Criteria could be incorporated into the researchers' evaluation regarding any form of dissemination they have accomplished (e.g. R&D). They should be allowed to earn profit from it or to upgrade their equipment. In place of academic disparagement or indifference to applications, a bona fide evaluation would take into account the scope of research operations carried out. Seeking and securing contracts would be a positive move, and the time devoted to collaborations would serve as an indicator of an institution's activity.

3.1.4 CONCLUSION

Clearly, the experts came to take an interest both in the scientific community they were scrutinising and in a country capable of gaining considerably from the sometimes impressive scientific capacity in place. Some teams truly have achieved a great deal with the limited means at their disposal.

It was no mean feat on the part of a team from the National School for Mining Engineering (Ecole Nationale de l'Industrie Minérale: ENIM), for instance, to have taken charge of several sheets of the geological map of Morocco, and then mounted an international consortium to compensate for the skills it lacked. It was quite an achievement on the part of a young female volunteer to have persuaded local authorities to pay — no matter how small a sum — for appropriate studies in earth sciences. And, furthermore, for a signal processing laboratory to have established itself as one of the leading 'European' groups

specialising in knowledge, and reproduction of techniques and materials used by classical, popular arts. Who would have thought that Morocco had the asset of a leading expert in decision-making mathematics (one of the most sought-after fields of expertise in the world) and top-notch clinicians, cited by global medicine?

Not enough can be said in tribute to the 300 or so researchers responsible for producing nearly one-third of all catalogued Moroccan science or the young scientists striving to gain recognition for their wealth of original, up-to-date ideas in the eyes of a sometimes awe-struck socio-economic world.

Equally clear is the fact that in the past few years the Department of Research has embarked upon a vigorous agenda of initiating the right kinds of projects, and has aimed to overcome the handicaps still affecting national research. Whether in terms of funding, equipment, pooling and development of human resources, cooperation or evaluation, the bottlenecks have been identified, and efforts are being made to improve efficiency.

Everyone involved is anxious to find the best ways to secure recognition for, and the reproduction and optimisation of, the country's outstanding existing capacities — a goal that the experts, too, have strived sincerely to help achieve.

3.1.5 ANNEX

Highlighted below are the agenda items for discussion at the cross-disciplinary workshops organised within the framework of the National Workshop on the evaluation of the Moroccan scientific research system (May 2003).

- **Underlying purpose of research: planning and indicators**

  - underlying purpose of research at various types of institutions, and its incorporation into a clear plan within the institutions;
  - evaluation of the institutions;
  - panel of indicators.

- **Organisation of research**

  - what is a 'laboratory'? — creation, approval, and side effects (e.g. funding, privileges and responsibilities of a 'laboratory director');
  - calls for tender and forms of structuring (e.g. centres of excellence and networks as well as scientific journals and associations);
  - evaluation of programmes and institutions.

- **Human resources**

  - researcher profession (e.g. status and careers) with case studies (e.g. research administrators, technicians and engineers);
  - effective contribution to research, evaluation, and incentives;
  - newcomers to the profession (e.g. fellowships for public sector and industrial);
  - continuous training of researchers, sabbaticals, bridges, and redeployment.

- **Budgets and funding**

  - basic support (exclusively for approved 'laboratories' or proportional to results?);
  - bids for tender, incentive budgets, and so forth;
  - own resources (e.g. funding earned through continuous training, service provision and consulting) and R&D contracts (e.g. assistance in seeking, negotiating and managing contracts);
  - monitoring procedures (e.g. a priori, a posteriori, and government procurement).

- **Equipment**

  - technical platforms (e.g. sharing and management of heavy equipment, and the agency in charge);
  - scientific information (e.g. travelling to conferences, access to journals, IMIST, and MARWAN);
  - procurement and maintenance (e.g. technicians and maintenance budget).

- **International cooperation**

  - cooperation agreements;
  - purpose (e.g. financial aid, updating, and upscaling);
  - 'subcontracting'.

- **Relations with the productive sector**

  - service agreements (e.g. continuous training, analysis, and consulting regulations);
  - applied research, development and demonstration, researcher and institution profits-sharing, evaluation of the work, and efficiency problems (e.g. deadlines, means, commitment to responsibility, and sound and stable quality);
  - industrial fellowships, research contracts, and intellectual property;
  - interface and meetings, and clubs, incubators and dissemination units.

The debates were underpinned by the experts' reports, the backgrounders produced for the evaluation, and various other documents prepared for the workshop by the Department of Research. The recommendations have been published by the Department of Research.