Kingdom of Morocco

Hassan II Academy of Science and Technology

Rabat

# Develop scientific research and innovation to win the battle of competitiveness

## Current situation and key recommendations

- November 2012 -

**His Majesty the King Mohammed VI, God bless Him**
**Tutor of the Hassan II Academy**
**of Science and Technology**

« **Serve the country and contribute to the development of world science** »
His Majesty the King Mohammed VI, God bless Him

Excerpt from the inaugural speech of His Majesty the King during the
installation of the Hassan II Academy of Science and Technology
(Agadir, May 18, 2006)

أكاديمية الحسن الثاني للعلوم والتقنيات

## Objective and methodology

In accordance with its mission "conducting studies, analysis and surveys related to scientific research" (Dahir-Law n°1-93-364 of October 6th, 1993), the Hassan II Academy of Science and Technology is presenting today, to the competent authorities and to the entire Moroccan scientific community, an overview report about the state of the national scientific research and its performances at regional level through qualitative and quantitative identification of its strengths and weaknesses. The report makes also as a series of pragmatic recommendations that might boost the national scientific research and innovation and which would enable our country to win the battle of competitiveness. These recommendations focus on three major axes: i) training and mobilization of human resources and competencies, ii) stimulation of the national research system, mainly for a better efficiency of its governance, and iii) the development of science education and scientific culture.

This collective work was realized in several steps.

An ad hoc committee[1], constituted in 2011 by the Hassan II Academy of Science and Technology with the help of the Ministry of Higher Education, Executive Training and Scientific Research, worked, from June 2011 to December 2011, on collecting and validating, data related to the human and financial resources allocated to the national research system. The retained quantitative data are the latest available ones and correspond to the year 2010. The data on track record in terms of scientific production were provided by IMIST (Moroccan Institute for Scientific and Technical Information) and the data related to private sector were obtained from "R&D Maroc" Association.

To all those who contributed to this work regarding data collecting and their validation, the Hassan II Academy of Science and Technology expresses its gratitude and thanks.

The general outline of the document as well as the proposals and recommendations it contains were submitted to the Academy members who discussed and validated them during the ordinary session of May, 18th, 2012. Taking into account the contributions and remarks made by the academicians, an editorial committee[2] ensured the writing and the finalization of this document, made available today to the reader.

[1] **Ad hoc Committee composed of:**

Hicham Boutracheh, *IMIST-CNSRT*; Abdelhak Chaibi, *R&D Maroc*; Abderrazak Chahboun, *Scientific Department (MESRSFC)*; Khalil El Akhlat, *Budget and Human Resources Department (MESRS)*; Najib El Hatimi, *Hassan II Academy of Science and Technology*; Mohammed Essaadaoui, *IMIST-CNRST*; Abdelouhed Ezzarfi, *Technology Department (MESRSFC)*; Abdelmajid Lafram, *Executive Training Department (MESRSFC)*; Larbi Lamrous, *Evaluation and Perspective Department (MESRSFC)*; Slimane Mehdad, *Scientific Department (MESRSFC)*; Najat Mokhtar, *Hassan II Academy of Science and Technology*.

[2] **Editorial committee composed of:**

Mohammed Ait Kadi, *Resident member of the Hassan Ii Academy of Science and Technology*; Mostapha Bousmina, *Chancellor and Resident member of the Hassan II Academy of Science and Technology*; Taieb Chkili, *Resident member of the Hassan II Academy of Science and Technology*; Omar Fassi-Fehri, *Permanent Secretary and Resident member of the Hassan II Academy of Science and Technology*; Albert Sasson, *Resident member of the Hassan II Academy of Science and Technology*.

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# Content

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# INTRODUCTION

To contribute to the definition of the national policy of scientific and technological research and to the evaluation of the implemented programs, the Hassan II Academy of Science and Technology worked out and released, May 2009, a report entitled “For a Relaunch of Scientific and Technological Research to Serve Morocco’s Development”. In that report, the Academy illustrated, through specific examples, the pertinence of scientific research for the development and for the future of Morocco. It particularly highlighted the indisputable accomplished progresses, but also weaknesses and mainly a serious and preoccupying evolution since 2003-2004. Indeed, using the latest statistical data, the report alerted national decision-makers on the urgency of taking measures aiming at boosting the national scientific research. To this end, the report proposed a series of concrete measures and recommendations, easily achievable, to give a new impetus to the National Scientific and Technological Research System and to make it resolutely at the service of the development by defining a strategy for the 2020 horizon.

After three years, it has to be recognized that the alert given in 2009 on the stagnation of Morocco, or even its lag behind comparable countries, for example in terms of scientific publications or national resources allocated to scientific research, remains valid.

We are still lagging far behind these countries. For example, Morocco currently ranks sixth in Africa in terms of scientific output, whereas till 2004, it was ranked in third position behind South Africa and Egypt. The number of students per 1,000 inhabitants, enrolled in higher education, remains very low with respect to comparable countries. The same trend is also noticed regarding the number of universities, researchers or graduates per year (scientists, engineers and specialists). The statistics presented in this document confirm these trends, despite the significant progression of the high school graduates, occurred during the latest years (212,000 new holders of high school diploma in June 2012).

The situation is even more worrying that Morocco has undertaken, under the aegis of His Majesty King Mohammed VI, the implementation of several ambitious sectorial development plans aiming at upgrading and leveling up the national socio-economic development in sectors such as energy, industry, agriculture, fisheries, new technologies, housing and tourism. However, one of the essential conditions for the success of such plans on medium and long terms is the implication of scientific research and training of highly qualified human resources to master the technological and scientific progresses and thus to contribute to innovation, which is necessary for the country's competitiveness.

As described in its mission, assigned by His Majesty King Mohammed VI, on May 18th, 2006, on the occasion of its installation, which is "to serve the country and contribute to the development of the worldwide science", it is therefore the duty of the Hassan II Academy of Science and Technology to **alert, reassure and suggest**.

Indeed, this report **alerts** and makes us to wonder about the future of national research and the nature and the pertinence of the underlying policies for its development. In this matter, there is, clearly no room neither for doubts nor for indifference.

The presented analysis serves as a barometer of the quality of R&D in the country. It aims at contributing to the assessment of the National Research System (NRS) with the objective to give rise to the necessary reorientations and readjustments.

This report also **reassures**, because despite the relative stagnation of the national research and the obstacles to its development, it highlights the undeniable achievements and poles of excellence on which the future can be built. It advocates peculiar choices to best valorize interests of the national collectivity; a potential that has been developed at great cost by the country.

Finally, this report proposes pragmatic measures with realism and objectivity; to create the conditions of the revival of the national research and the valorization of its results.

A real revival of the national research that is presently at the crossroads, will likely create the adequate conditions to stimulate the research activities, to enhance its performances, and to make it play a crucial role in the development and the competitiveness of the country.

The undertaken work for the realization of this report is presented in the three following chapters concerning: strengths and weaknesses of the current research system; the new issues of scientific research in Morocco and the challenges to face; along with the proposed recommendations to insure its revival.

Following the publication of this report, the Academy will prepare and publish reports on the state of research in the major fields of knowledge by disciplinary sector.

أكاديمية الحسن الثاني للعلوم والتقنيات

# Chapter I

## CURRENT SITUATION: SOME SUCCESSES TO CONSOLIDATE AND NUMEROUS WEAKNESSES TO CORRECT



**The objective of this part dedicated to the analysis of the evolution of the current situation of scientific research in Morocco is to assess, in a factual and rigorous way, the state of the national research-development system, in order to:**

- **Inform decision makers, operators**, national scientific community and all concerned persons about the realized progress, strengths and weaknesses;
- **Contribute to the brainstorming on national scientific** research in terms of governance as well as its operational aspects and results;
- **Enrich a constructive debate** based on objectivity and facts rather than on baseless prejudices and a priori.

It includes three sections :

- The first one is dedicated to the data concerning human resources, number of researchers, Ph.D students and students enrolled in higher education and the quantitative comparison of such data with those of similar countries,
- The second consists of assessing the level of public and private research funding and the processes and procedures regarding the allocation of resources and their management,

- The third section is dedicated to the quantitative analysis of the national track record in terms scientific dissemination, and the assessment of progresses and weaknesses on the basis of measurable input-and-output indicators. It also concerns the exhaustive evaluation of quantitative and qualitative performances of the national scientific and technological production.

Indeed, the final goal is to make objective proposals and recommendations, corresponding to the current priorities and issues, which would enable decision makers, in consultation with all other stakeholders, to have a consensual and proactive overview and a clear master plan for giving a new breath and a driving pulse for R&D in Morocco.

## A. Research-development staff

According to Frascati standards of the OECD countries, scientific research staff is defined as an ensemble of persons participating directly to the activities of research in an institution or a unit, and who, in general, are paid in return. Thus, the scientific research staff concerns the researchers (faculty, researchers, whether permanent or temporary), and the support staff. The research staff also includes scientists (researchers, faculty, Ph.D students), engineers, technicians and support-and-assistant staff.

The analysis of the indicators related to scientific research staff, both on quantitative (number, distribution by domain and structure) and qualitative bases (training level, degree of motivation and commitment), permits the assessment of the productivity and its quality.

### A.1. number of scientific research staff

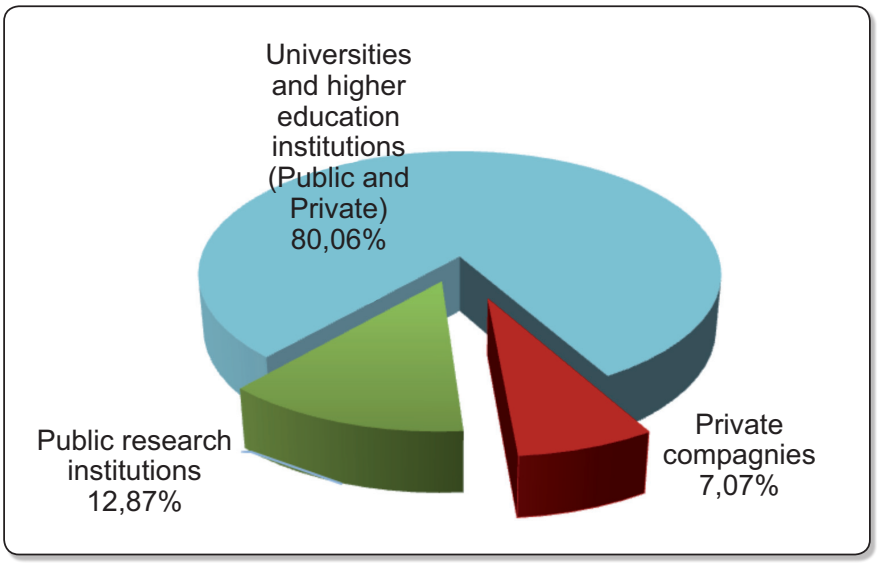
**In 2010,** scientific research staff in Morocco had some activities in 618 Moroccan institutions (higher education, public and private sectors, public institutions and private enterprises). The number of this staff increased to 37,246 persons, as follows :

- 9,819 working in higher education (universities and higher education institutions not belonging to universities, whether private or public),

- 4,794 working in a R&D activity in public research institutions, not belonging to the higher educational system (such as INRA, CNESTEN, INRH…),
- 2,633 working in R&D activities within private companies (table A1 in annex).

The proportion of research staff is about 80% within public or private higher education sector, about 13% within public research institutions and 7% within private companies (graph 1 and annex : table A1).

It is to be noted that over 29,819 persons working in the higher educational system :
- 12,133 are faculty members, who represent 33%,
- 17,686 are graduate students preparing a doctoral thesis, 47%,
- 20% are researchers, engineers, technicians and related staff.




**Graph 1. Distribution of the research staff in 2010 within private and public sectors**

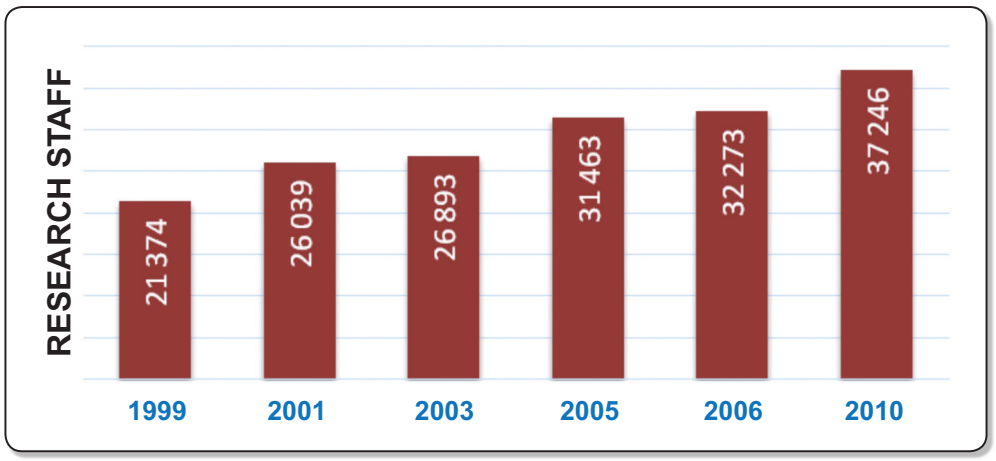
### Evolution of the number of research staff

As indicated in table 1 and graph 2, between 1999 and 2010, the number of scientific research staff has increased by 74%, shifting from 21,374 to 37,246.
In public sector, these numbers have increased by 64%, from 20,724 to 34,101; whereas in private sector, this number rose by 383%, increasing from 650 to 3,145.

**Table 1. Evolution of the number of research staff between 1999 and 2010**

| | 1999 | 2001 | 2003 | 2005 | 2006 | 2010 | Evolution (%) 1999/2010 |
|---|---|---|---|---|---|---|---|
| **Research staff of Private sector** | 650 | 750 | 858 | 1,728 | 2,454 | 3,145 | +383% |
| **%** | 3% | 3% | 3% | 5,5% | 7,6% | 8,4% | 181% |
| **Research staff of Public sector** | 20,724 | 25,289 | 26,035 | 29,753 | 29,837 | 34,101 | 64.54% |
| **%** | 97% | 97% | 97% | 94,5% | 92,4% | 91,56% | -5,60% |
| **Total staff** | 21,374 | 26,039 | 26,893 | 31,463 | 32,273 | **37,246** | 74.25% |

*Sources : MESRSFC (DEP – DFC) - Ministères techniques – EPR – R&D Maroc*



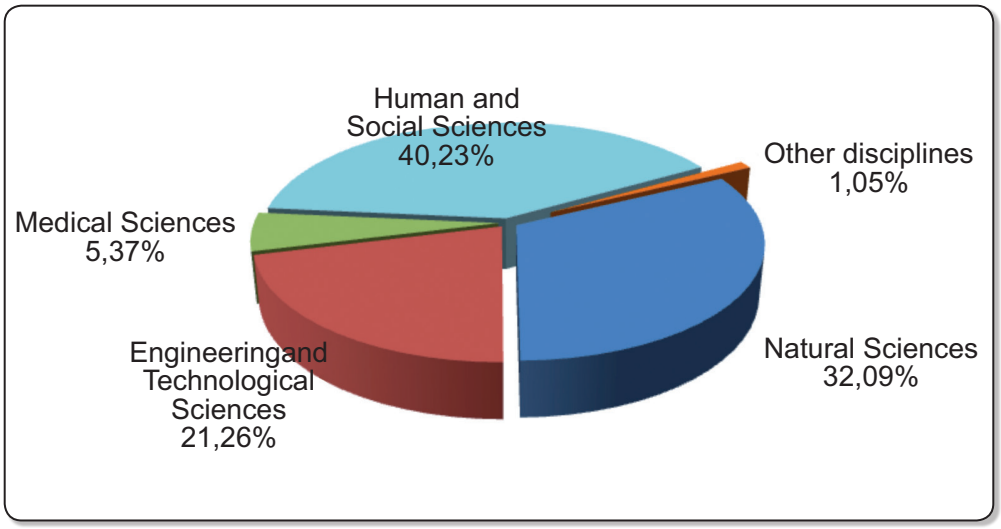

**Graph 2. Evolution of the number of research staff between 1999 and 2010**

## A-2. Distribution of the research staff

Table 3 shows that between 1999 and 2010, the distribution of research staff between the private and the public sectors has changed very little. In 2010, the percentage of researchers working in the private sector represented 8.5%, whereas they were only 3% eleven years earlier. Therefore, by comparing the number of researchers in public and private sectors, it is noted that the proportion of researchers belonging to private sector has increased by 181% between 1999 and 2010, **whereas those of public sector decreased by 5.6%**.

The graph 3 and table A2 (in annex) indicate **the distribution by disciplinary field**, corresponding to 2010; they are about:

- 32.1% in Natural Sciences: (physics, chemistry, mathematics, biology, geology…)
- 21.3% in Engineering and Technological Sciences;
- 5.4% in Medical Sciences;
- 40.2% in Human and Social Sciences;
- 1.0% in other disciplines.




**Graph 3. Distribution of the number of research staff by disciplinary field in % for the year 2010**

## A.3 Ph.D Students

At international level, the analysis of the scientific research indicators includes also graduate students (Ph.D and MSc.), since these represent a significant element that reflects the vitality and the degree of development of the national research system.

**a. Number of enrolled graduate students.**

In 2010, there were 39,381 graduates enrolled in different curricula (cf. table A4 in annex):

- 19,195 in Master (48.74%)
- 16,054 in Doctorate (40.77%)
- 1,720 in DMS (Diploma of Medicine Specialty) (4.37%)

- 2,412 in Ph.D (4.14%), in DESA (DES - Diploma of Extensive Studies) (1.32%), in DESS (DSHS - Diploma of Specialized Higher Studies) (0.37%), and in DD (Diploma of Dentistry) (0.29%). All these diplomas will gradually disappear to comply with the new LMD (License-Master-Doctorat) system adopted in 2003.

It's noteworthy to highlight two features characterizing graduate studies: i) the number of students enrolled in graduate studies remains low with respect to the requirements of the renewal of faculty staff and of the natural increase in the number of students in higher education and ii) Ph.D students represent half of the total number of graduates.

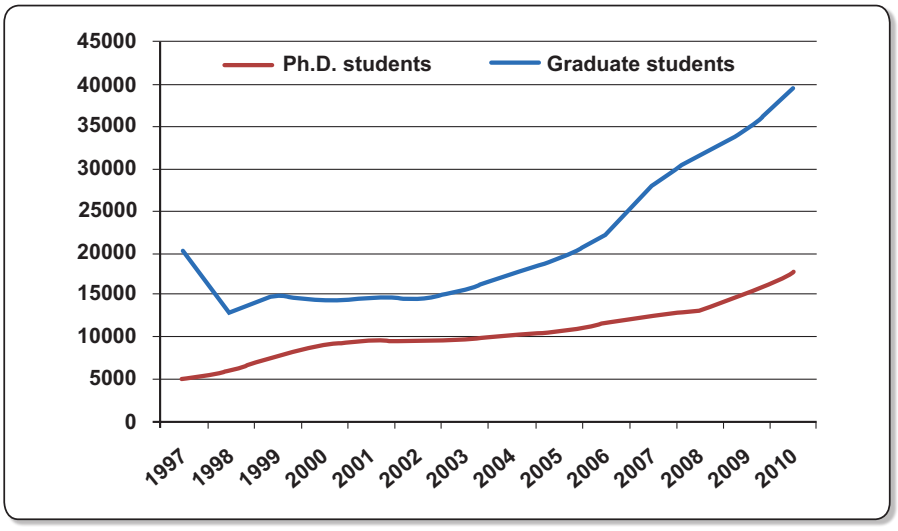
The distribution by year (between 1997 and 2010) and by domain of students enrolled in graduate studies is given in table 5, in annex.

For 2010, the distribution is as follows:

- **Human and Social Sciences: 23,508 students representing 59.69%**
- **Life and Matter Sciences: 15,875 students (40.31%)**
- **Medical Sciences: 1,920 students (4.87%)**
- **Engineering Sciences: 1,148 students (2.91%)**

Thus, in 2010, the total number of graduate students was of 39,381 compared to 34,299, in 2009. Since 1998, this number has increased by more than 19,359 students as compared to 1997, representing +96% (see table A3 in annex, and graph 4).

It is has also to be noticed that, between 1997 and 2010, the number of students enrolled in life and matter sciences increased by 198%, and those in human and social sciences by 57%.




**Graph 4. Evolution of the number of graduate students between 1997 and 2010**

## b. Evolution of the total number of awarded PhDs

Between 1996 and 2010, the total number of awarded PhDs was of 10,121. This represents in average about 675 awarded PhDs per year, which is a low number compared to the needs of the country, in particular for the renewal of the retiring faculty members.

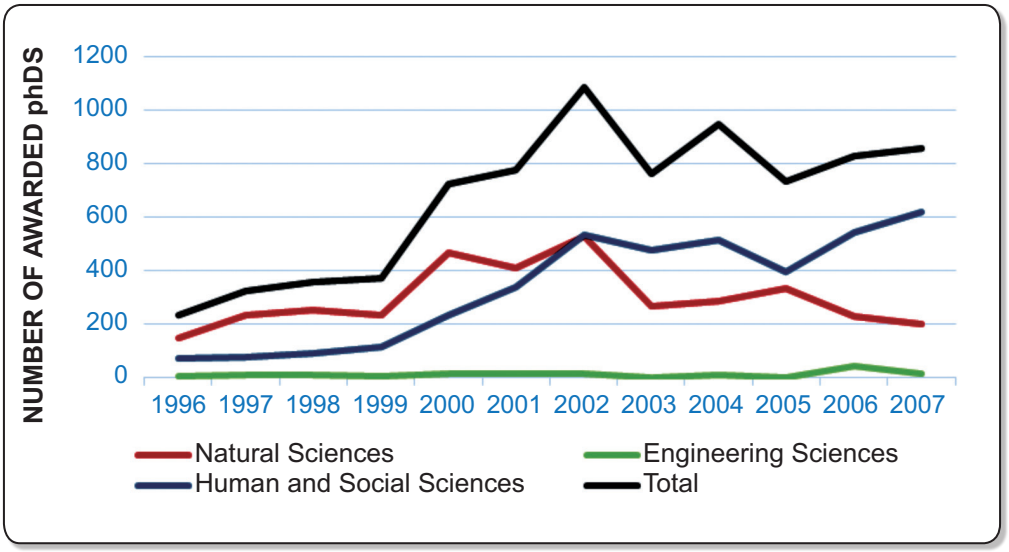
**Table 2. Evolution of the number of awarded PhDs between 1996 and 2010**

| Disciplinary field | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural Sciences | 150 | 137 | 197 | 238 | 469 | 411 | 545 | 276 | 415 | 331 | 237 | 322 | 207 | 269 | 366 |
| Engineering Sciences | 6 | 9 | 11 | 11 | 19 | 21 | 15 | 9 | 16 | 9 | 48 | 23 | 23 | 30 | 30 |
| Human and Social sciences | 75 | 79 | 95 | 124 | 240 | 351 | 535 | 483 | 523 | 402 | 541 | 501 | 630 | 337 | 355 |
| **Total** | **231** | **225** | **303** | **373** | **728** | **783** | **1095** | **768** | **954** | **742** | **826** | **846** | **860** | **636** | **751** |

*Sources : MESRSFC (DEP – DFC)*

The awarded PhDs during 1996 and 2010 are distributed as follows: (see table 2 and graph 5):

- 5,271 in Human and Social Sciences (about 52%)
- 4,570 in Natural Sciences (about 45%)
- 280 in Engineering Sciences (about 3%)




**Graph 5. Evolution of the number of awarded PhDs between 1996 and 2010**

### c. PhDs awarded in 2010 by disciplinary field

Out of 751 PhDs awarded in 2010 (table A5 in annex):

- 355 were in Human and Social Sciences (47%)
- 366 in Life and Matter Sciences (49%)
- 30 in Engineering Sciences (4%).

In the same context, over the 377 PhDs awarded in Human and Social Sciences in 2010 (the percentage with respect to the total PhDs awarded in 2010 is given between brackets), there were:

- 107 in law (16%)
- 84 in Languages Teaching (12%)
- 65 in Islamic Studies (10%)
- 33 in Economic Sciences (5%)
- 27 in Education Sciences (4%)
- 24 in History (4%)
- 15 in Philosophy and Sociology (2%)
- 13 in Geography (2%)
- 9 in Teaching (1%)

Regarding the distribution of the 269 PhDs awarded in Life and Matter Sciences (the percentage with respect to the total number of PhDs awarded in 2010 is given between brackets) is as follows:

- 76 in Life Sciences (11%)
- 76 in Physics (11%)
- 49 in Chemistry (7%)
- 34 in Mathematics (5%)
- 12 in Earth Sciences (2%).

**Globally, among the total number of awarded PhDs per year, one third (1/3) is in Pure and Applied Sciences (Life and Matter Sciences and Engineering Sciences) and two thirds (2/3) are in Human and Social Sciences.**

## A-4. Students enrolled in higher education

Analysis of number of students enrolled in higher education, their evolution and their distribution highlights the weakness of our higher educational system, in comparison with the neighboring countries having quite similar level of development. Notwithstanding, for the year 2012-2013, the number of students reached 512,000, representing an increase of about 16% compared to the previous year. This is basically due to the substantial increase in the number of new high school awardees in 2011 and 2012.

### a. *Evolution of the numbers students in higher education for the period 2000-2010*

In 2010, the total number of students enrolled in higher education throughout the various curricula and cycles reached 447,000, including professional training, BTS (specialized technician certificate – brevet de technicien spécialisé), preparatory classes for schools and teachers' training (see table 3 and graph 6).

Over **100** students enrolled in higher education in **2010**:
- 68.75 enrolled in university, LMD teaching
- 5 enrolled in non-academic institutions of higher education
- **8** in **private** higher education
- 16 in professional training institutions (post-baccalaureate)
- 0.5 in BTS training classes
- 0.5 in teachers' training
- 1.25 in preparatory classes.

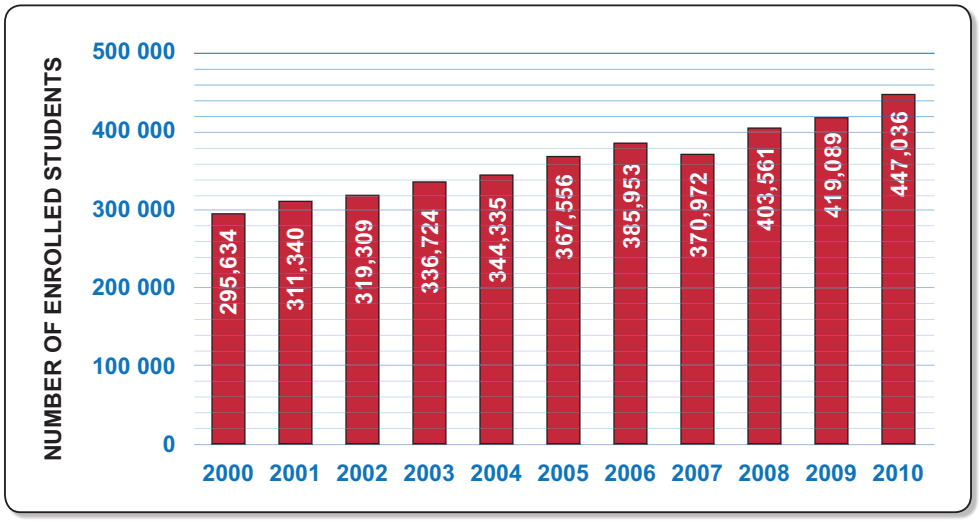
The evolution of the numbers between 2000 and 2010, reveal a positive and an encouraging development in several sectors of higher education:

- The number of students enrolled in professional education increased by 697%;
- the number of students enrolled in private higher education increased by 246%;
- the number of students in preparatory classes increased by 183%;
- the number of students in BTS increased by 181%;
- the number of students in universities increased by 23%;
- and in the executive training institutions, there was an increase of 105%.

**Table 3. Number of students enrolled in higher education between 2000 and 2010**

| Type of institution | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Changes (%) 2000/2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| University education | 250,111 | 261,629 | 266,621 | 280,599 | 277,632 | 293,866 | 301,638 | 273,878 | 292,776 | 293,642 | 308,005 | 23 |
| Executive education | 10,889 | 11,189 | 12,303 | 13,972 | 16,336 | 14,816 | 16,549 | 16,913 | 18,368 | 19,226 | 22,277 | 105 |
| Private higher education | 10,146 | 11,519 | 13,425 | 15,483 | 17,558 | 19,215 | 21,537 | 22,456 | 25,068 | 30,541 | 35,118 | 246 |
| **Total** | **271,146** | **284,337** | **292,389** | **310,054** | **311,526** | **327,897** | **338,713** | **311,947** | **336,212** | **343,409** | **365,400** | **35** |
| Professional higher education | 9,004 | 10,619 | 12,825 | 16,776 | 23,966 | 31,663 | 40,090 | 50,697 | 59,652 | 67,176 | 71,745 | 697 |
| CFI | 12,688 | 13,142 | 10,159 | 5,096 | 3,885 | 2,712 | 1,140 | 1,214 | 1,476 | 8,96 | 2,000 | -84 |
| BTS | 818 | 961 | 1,287 | 1,762 | 1,747 | 1,944 | 2,038 | 2,080 | 1,970 | 2,003 | 2,302 | 181 |
| CPGE | 1,978 | 2,281 | 2,689 | 3,036 | 3,211 | 3,340 | 2,961 | 3,734 | 4,251 | 5,605 | 5,589 | 183 |
| **Total** | **24,488** | **27,003** | **26,960** | **26,670** | **32,809** | **39,659** | **46,229** | **57,525** | **67,349** | **75,680** | **81,636** | **233** |
| **All** | **295,634** | **311,349** | **319,309** | **336,724** | **344,335** | **367,556** | **385,953** | **369,672** | **403,561** | **419,089** | **447,036** | **51** |

*Sources : MESRSFC (DEP – DFC) - Ministères techniques*




**Graph 6. Evolution between 2000 and 2010 of the number of students enrolled in higher education**

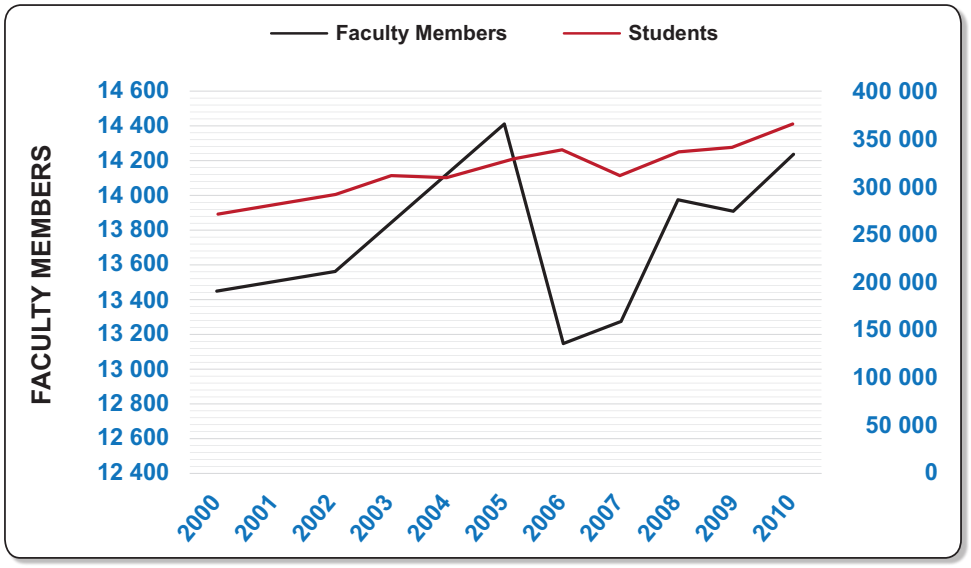
### b. *Evolution between 2000 and 2010 of the number of students and faculty members*

From 2000 to 2010, the total number of faculty members (professors-researchers) slightly increased. Within 10 years, it has evolved from 13,453 to 14,423, a progression of +5.80%. This evolution is characterized by significant decrease between 2005 and 2007, since the number of faculty members changed from 14,416 in 2005 to 13,149 in 2006, representing a total drop of -1267 faculty, which is explained by the program of voluntary leave for retirement that has dramatically impacted the faculty members category, both qualitatively and quantitatively (see table 4 and graph 7).

**Table 4. Evolution of the number of students enrolled in universities and of faculty members between 2000 and 2010**

| Type of institution | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Changes (%) 2000/2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Faculty Members | 13,453 | 13,516 | 13,568 | 13,824 | 14,107 | 14,416 | 13,149 | 13,280 | 13,976 | 13,909 | 14,234 | 5,80 |
| Students | 271,146 | 284,337 | 292,389 | 310,054 | 311,526 | 327,897 | 338,713 | 311,947 | 336,212 | 343,409 | 36,500 (*) | 34,76 |
| Pupil ratio | 20 | 21 | 21 | 22 | 22 | 22 | 26 | 23 | 24 | 25 | 26 | |
| *Sources : MESRSFC (DEP – DFC)* | | | | | | | | | | | | |

However, between 2000 and 2010, the number of students increased by +34.76%, evolving from 271,146 to 365,400.




**Graph 7. Evolution of the number of faculty members and of students between 2000 and 2010**

The evolution of the number of faculty members had a negative impact on students training and supervision and also on scientific production. Indeed, the rate of supervision changed from 20 students per professor in 2000 to 26 students per professor in 2010. In universities, this ratio changed from 26 in 2000 to 30 in 2010.

This decline, which can have serious consequences on the quality of education and scientific production, will drastically rise in the short term, including this year, due to the increase in the number of students in higher education noted these latest years, and which seems to be of structural trend (about 18% per year). If this situation is not rapidly dealt with, we would have an important imbalance with negative consequences for the quality of students' training and for the development of scientific research within the universities.

**For the year 2012-2013, the number of students enrolled in higher education reached 512,000.**

## A-.5. Comparison of Moroccan data with those of some countries

### a. Number of research staff

In 2009, the number of full time research staff reached 20,703. Compared to the active population, this represents 1.77 researcher for 1,000 active persons. In comparison with a sample of 14 selected countries (see table A6 in annex), Morocco is right behind the following countries: South Korea (9.8/1000 active persons), Portugal (8.13/1000), Turkey (8.02/1000), Spain (5.88/1000), Czech Republic (5.54/1000), Tunisia (5.10/1000), France (2.35/1000), and Romania (2.01/1000). However, Morocco comes before Algeria (1.56/1000), Egypt (1.26/1000) and Senegal (0.90/1000).

The table A7 in annex, recapitulating the number of students enrolled in higher education in 2010, shows that, for Morocco, the ratio of the number of students per 1,000 inhabitants is very low (14%) as compared to Algeria (32%), Tunisia (34%) and Jordan (40%).

**b. Number of faculty members and rate of supervision**

Between 2005 and 2009 (Table A8 in annex), the number of professors in higher education changed from 14,416 to 13,909, a diminution of 507 (-3.52%), whereas other countries have had an important increase: Jordan with an evolution of +65%, followed by Algeria (52.43%), Malaysia (46.28%), Turkey (22.42%) and Tunisia (20.26%).

The supervision rate in Morocco reached 22 students per professor in 2005. This rate is better than that of Senegal (54), Egypt (32), Algeria (27), Turkey (26), Jordan (26) and Romania (24). However, it is lower than Portugal (10), Spain (12), Czech Republic (14), France (16), Malaysia (17), South Korea (17) and Tunisia (19).

**c. Graduated students in higher education**

The total number of students graduated from Moroccan higher education evolved from 48,162 in 2005 to 70,780 in 2009. Such increase remains however low compared to other countries (see table A9 in annex). France delivered 664,711 diplomas in 2005 and 621,444 in 2009, followed by south Korea (607,982 in 2005 and 595,125 in 2009), Turkey (258,858 in 2005 and 488,803 in 2009), Spain (298,448 in 2005 and 310,452 in 2009), Romania (156,565 in 2005 and 310,886 in 2009), Malaysia (202,703 in 2005 and 206,588 in 2009) and Algeria (154,838 in 2009). The countries that delivered less diplomas than Morocco are: Tunisia (28,565 in 2005 and 65,630 in 2009) and Jordan (42,294 in 2005 and 49,574 in 2009), that have however lesser population.

**In the light of the previous analysis related to the situation of human resources, the following conclusions are drawn:**

- **The number of the scientific research staff (all categories) stagnated with a negative recruitment rate (-3%), whereas in the reference countries selected for comparison such a rate was characterized by an important and continuous increase.**
- **The rate of students' supervision for training and research is not satisfactory, with an expected worse situation in the very short term. It is explained by an annual increase of about 20% in the number of students since 2010, which is not matched by a corresponding increase in the number of total faculty members.**
- **The number of PhD students, of graduates and of students enrolled in higher education is 2.5 times less than that of Algeria, and it barely exceeds that of Tunisia.**
- **The number of delivered PhD Diplomas, in all fields, is extremely low (676 in 2009) and the current situation is characterized by the absence of a clear training policy of future faculty members that should respond to the current and future needs of the country.**

Beside these remarks made from quantitative encrypted data, the situation in terms of supervision and human resources is worsened by:

- **the absence of a policy for the management and valorization of research human resources;**
- **the absence of a strategy aiming at putting in place truly incentive mechanisms and a fair emulation within the scientific community and a recognition of the research function and activities;**
- **the absence of the status of professor-researcher, which valorizes the activity of research. It unfortunately seems that in the framework of the current status (1997), commitment in research is rather discouraged than encouraged.**

## B. Financial resources devoted to scientific research

In this part, the available data on public and private financial resources, allocated to scientific research, as well as the evolutive trends and their repartition per domain are presented for a small part of the operating budget, since the major part is dedicated to salaries. As for equipment budget, it mainly concerns data related to allocated resources and not actually expended ones. For several institutions, it turned out that this latter information was difficult to obtain.

### B-1. National GERD

According to Frascati's criteria, the GERD (Gross Domestic Expenditure on Research and Development) is the total intramural expenditure related to R&D activities carried out in the national territory during a given period (one year). It also includes the R&D carried out within the national territory and financed by external resources, excluding the payments made out of the country for subcontracting R&D.

The national GERD is composed of the public GERD, private enterprises' GERD and the one obtained form the international cooperation (graph 8).

Between 1999 and 2010, the National GERD has increased steadily from 1.45 billion Dirhams in 1999 to nearly 5.6 billion Dirhams in 2010, an increase of more than 284% (see table 5 and graph 8). It has to be mentioned that the contribution of the wages for faculty members in the calculation of Morocco's GERD only corresponds to the research indemnity part included in their salaries, unlike the practices in the majority of other countries, which count the whole salary of the faculty members.

It's also worth to point out the significant progression in the participation of the private sector, whose contribution in volume evolved from 7% in 1999 to almost 30% in 2010. The data for the private sector were obtained through direct surveys within the national important companies, and also thanks to the help of R&D Maroc Association.

**Table 5. Composition of GERD and evolution between 1999 and 2010 in Millions DH (MDH)**

| | 1999 | 2001 | 2003 | 2006 | 2010 | Change (%) 1999/2010 |
|---|---|---|---|---|---|---|
| GERD | 1,456.46 | 2,367.68 | 3,116.02 | 3,693.98 | 5,606.46 | 284.93 |
| Financing by the public sector | 1,335.46 | 1,905.48 | 2,578.81 | 2,819.77 | 3,832.04 | 186.94 |
| Public Sector (%) | 91.69 | 80.47 | 82.75 | 76.32 | 68.35 | -25.45 |
| Financing by the private sector | 101.00 | 443.20 | 455.90 | 792.59 | 1678.46 | 1561.84 |
| Private sector (%) | 6.93 | 18.71 | 14.63 | 21.45 | 29.93 | 331.89 |
| Financing through cooperation | 20.00 | 20.00 | 81.31 | 81.62 | 95.96 | 379.8 |
| International Cooperation (%) | 1.37 | 0.84 | 2.60 | 2.21 | 1.71 | 24.81 |
| GDP | 389,786 | 426,871 | 476,987 | 575,271 | 764,300 | 96.08 |
| Share of GERD in GDP in% | 0.37% | 0.55% | 0.65% | 0.64% | 0.73% | 97.29 |
| Share of public GERD in GDP in % | 0.34% | 0.44% | 0.54% | 0.49% | 0.50% | 47.05 |
| Share of private GERD in GDP in % | 0.025% | 0.10% | 0.09% | 0.14 | 0.22% | 780 |
| Share of GERD cooperation in GDP in % | 0.005% | 0.01% | 0.01% | 0.01% | 0.01% | 100 |

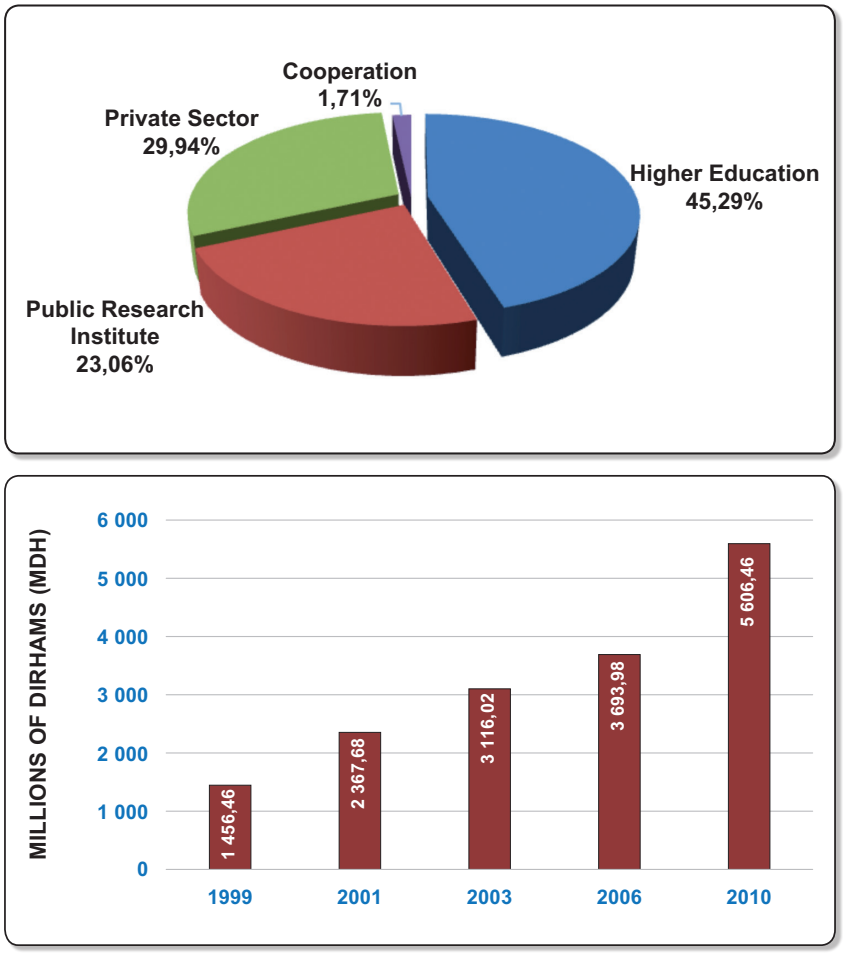
## B-2. Distribution of GERD by research purposes

In 2010, the funds allocated to R&D activities of the laboratories of higher education institutions and which cover all scientific domains, represented 45.28% of the total R&D expenditures at national level (table 6).

Concerning the expenditures related to R&D activities by other departments of the public sector, they represented 36.11% for the sectors of energy, water, mines and manufacturing products, 5.74% for agriculture, 3.13% for telecommunications, informatics and space, and 2.33% for fisheries. The proportion of expenditures devoted to R&D activities in the health sector represented only 1.14% of the total expenditures, while the equipment sector (Building and civil engineering) was ranked the last position with 0.85% (see table 6).

**Table 6. Distribution of GERD by research purposes in 2010**

| Main purpose of research | Volume (millions de DH) | Part (%) |
|---|---|---|
| University research | 2 538,81 | 45,28 |
| Biomedical research outside university | 64,15 | 1,14 |
| Agricoltural research outside university | 322,10 | 5,74 |
| Halieutic research outside university | 130,72 | 2,33 |
| Research linked to equipments and infrastructures outside university | 48,05 | 0,85 |
| Research in the sectors of energy, water, mining and manufactured products | 2024,93 | 36,11 |
| Research on history, cultures and societies outside university | 117,57 | 2,09 |
| Telecommunication, computer science, nanotechnology and space outside university | 175,49 | 3,13 |
| Support actions to R&D | 88,68 | 1,58 |
| Cooperation actions | 95,96 | 1,71 |
| Total expenditures | 5 606,46 | 100 |




**Graph 8. Composition and amount of GERD**

## B-3. Comparison with other countries

*In 2010, the percentage of the Gross Domestic Product (GDP) dedicated to R&D in Morocco was 0.73%; which ranks Morocco among the countries that devote between 0.5 and 1% of their GDP to R&D.*

Among the list of the selected countries, those that devote between 1% and 2% of their GDP to R&D are Portugal (1.66%), Czech Republic (1.53%) and Spain (1.38%) and those that allocate more than 2% are France (2.23%) and South Korea (3.36%) (See table 7).

With 0.73% of GDP dedicated to R&D, Morocco has not reached yet the objective set by the chart for education and training worked out by COSEF (Commission Spéciale Education Formation – Special Commission for Education and Training) and which had set an objective to achieve of 1% of GDP by 2010. However, between 1999 and 2010, the part of the Moroccan GERD in GDP increased by +97%, evolving from 0.37% in 1999 to 0.73% in 2010.

**Table 7. Part of the national GDP dedicated to R&D**

| Type of institution | Share of GDP (%) | | | | | Change (%) 1999/2010 |
|---|---|---|---|---|---|---|
| | 1999 | 2001 | 2003 | 2006 | 2010 | |
| Tunisia | 0.43 | 0.53 | 0.73 | 1.06 | 1.10 | 155.81 |
| Portugal | 0.65 | 0.8 | 0.74 | 0.8 | 1.66 | 155.38 |
| Turkey | 0.37 | 0.54 | 0.48 | 0.58 | 0.85 | 129.73 |
| **Morocco** | **0.37** | **0.55** | **0.65** | **0.64** | **0.73** | **97.30** |
| Spain | 0.87 | 0.91 | 1.05 | 1.15 | 1.38 | 58.62 |
| South Korea | 2.34 | 2.59 | 2.63 | 3 | 3.36 | 43.59 |
| Czech Republic | 1.15 | 1.20 | 1.25 | 1.55 | 1.53 | 33.04 |
| Romania | 0.35 | 0.38 | 0.40 | 0.45 | 0.48 | 37.14 |
| Egypt | 0.20 | 0.19 | 0.27 | 0.26 | 0.21 | 5 |
| France | 2.14 | 2.20 | 2.17 | 2.15 | 2.23 | 4.20 |
| Malaysia | | 0.40 | 0.65 | 0.63 | - | |
| Algeria | 0.19 | 0.23 | 0.20 | | | |
| Jordan | | | 0.3 | 0.34 | 0.42 | |
| Senegal | | | | | 0.37 | |

*Sources : MESRSFC (DEP – DFC)*

**To sum up, the analysis on the data presented above indicates:**

- **A positive evolution of the national GERD**
- **A significant increase in the national GERD from private sector and public institutions not belonging to universities, notably OCP (Office Chérifien des Phosphates, and the department of energy)**
- **A contribution to the GERD of more than 45% by university sector**
- **The GDP part allocated to research remains less than 1%.**

## C. Scientific production

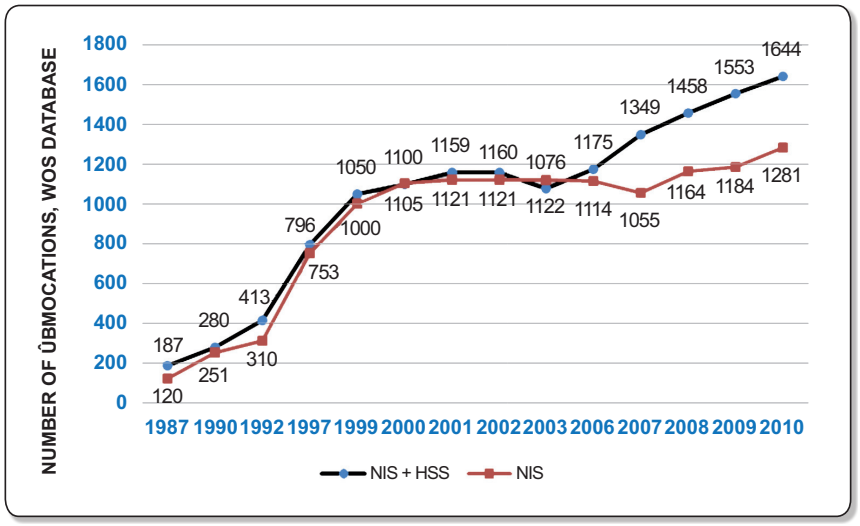
The track record in terms of scientific production of a country is measured by the number of peer-reviewed publications in indexed international scientific journals. It encompasses also the works edited in peer-reviewed valuable scientific books, and registered patents at international level.

### C-1. Evolution

To appreciate the track record of Morocco in terms of scientific production, referenced in peer-reviewed and indexed journals, we used the bibliometric Web of Science (WOS) database, edited by the American company "Thomson Reuters" and made available by IMIST. We also used SCOPUS database owned by Elsevier. According WOS, the Moroccan scientific production, between 1987 and 2003, has significantly improved and was ranked third in Africa, right behind South Africa and Egypt, as shown in the international statistics.

However, since 2003-2004, the rhythm of growth of this production has dramatically slowed down leading to stagnation, if not to a decrease that lasted until 2007. A small upward trend is noticed from 2007 and on (table 8 and graph 9).

Despite this increase, Morocco moved from the 3rd to the 6th place in 2010, at the African level.




**Graph 9. Moroccan scientific production (WOS data)**

## C-2. Moroccan scientific production per scientific domain

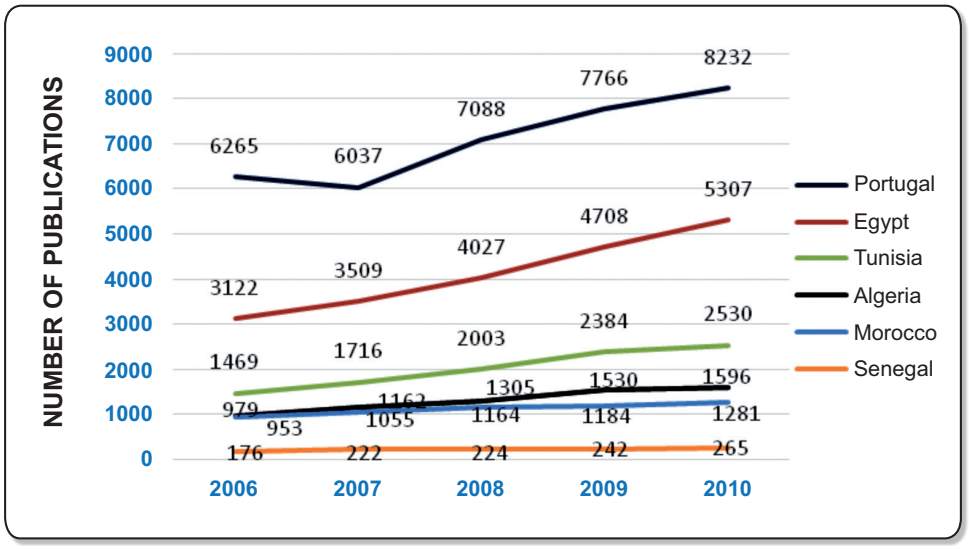
Precisely, between 2006 and 2010, the Moroccan scientific production in the fields of Pure and Applied Sciences (Natural Sciences, Engineering Sciences and Technologies, Medical and Agricultural Sciences) increased by 33.5%, from 959 to 1,281 articles per year (see table 8).

Despite this, the Moroccan scientific production is ranked behind Portugal, Egypt and Tunisia (see graph 10).

**Table 8. Number of scientific productions**

| | 2006 | 2007 | 2008 | 2009 | 2010 | Change (%) 2006/2010 |
|---|---|---|---|---|---|---|
| Natural Sciences | 629 | 666 | 720 | 748 | 811 | 29 |
| Engineering Sciences and Technology | 254 | 255 | 313 | 285 | 296 | 16.5 |
| Medical Sciences | 244 | 293 | 316 | 340 | 311 | 27.4 |
| Agricultural Sciences | 69 | 55 | 83 | 79 | 75 | 8.7 |
| Total | 1,196 | 1,269 | 1,432 | 1,452 | 1,493 | 33.5 |
| *Sources Thomson Scientific ; IMIST-CNRST* | | | | | | |

*N.B.: It has to be noticed that the sum of the productions in the four domains does not equal the global production, which is might be due to the possibility of multiple indexation of publications in different categories of WOS.*




**Graph 10. Evolution of the annual scientific production in Morocco and other countries (WOS database)**

## C-3. Global share

The global share of publications is the ratio between the number of publications of a country and the number of global worldwide publications. The global share of the Moroccan scientific production enables to position Morocco according to the global production in terms of publications.

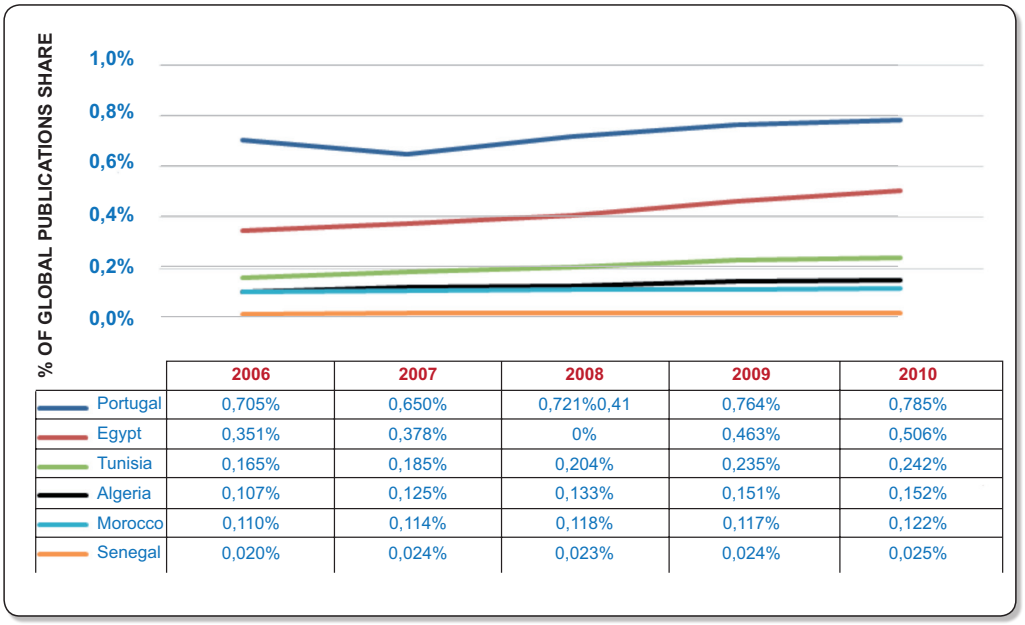
In 2010, the scientific production of Morocco represented a contribution of 0.122% of the global production (see table 9 and graph 11). Since 2006, Morocco's global share has known serious stagnation (see graph 11) and is lagging far behind with respect to some countries of the region such as Egypt and Tunisia.

Viewed with respect to the total research staff in Morocco and Tunisia (about 12,000 for each country), Moroccan scientific production in 2010 is about half that of Tunisia.

In other words, a Tunisian faculty member produces twice more publications than his Moroccan colleague.

**Table 9. Global share (%) of publications of Morocco and other countries for 2010**

| | Morocco | Tunisia | Algeria | Egypt | Portugal | Senegal |
|---|---|---|---|---|---|---|
| **Global shares (all disciplines)** | 0.122% | 0.208% | 0.135% | 0.425% | 0.727% | 0.023% |
| **Global shares in Natural Sciences** | 0.130% | 0.213% | 0.168% | 0.440% | 0.865% | 0.020% |
| **Global shares in Engineering Sciences and Technology** | 0.117% | 0.280% | 0.250% | 0.543% | 0.922% | 0.013% |
| **Global shares in Medical Sciences** | 0.094% | 0.176% | 0.030% | 0.370% | 0.452% | 0.030% |
| **Global shares in Agricultural Sciences** | 0.123% | 0.331% | 0.109% | 0.498% | 0.977% | 0.054% |
| *Sources Thomson Scientific ; IMIST-CNRST* | | | | | | |




| | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Portugal | 0,705% | 0,650% | 0,721%0,41 | 0,764% | 0,785% |
| Egypt | 0,351% | 0,378% | 0% | 0,463% | 0,506% |
| Tunisia | 0,165% | 0,185% | 0,204% | 0,235% | 0,242% |
| Algeria | 0,107% | 0,125% | 0,133% | 0,151% | 0,152% |
| Morocco | 0,110% | 0,114% | 0,118% | 0,117% | 0,122% |
| Senegal | 0,020% | 0,024% | 0,023% | 0,024% | 0,025% |

**Graph 11. Evolution of the global share (%) of publications of Morocco and other countries**

## C-4. Index of specialization

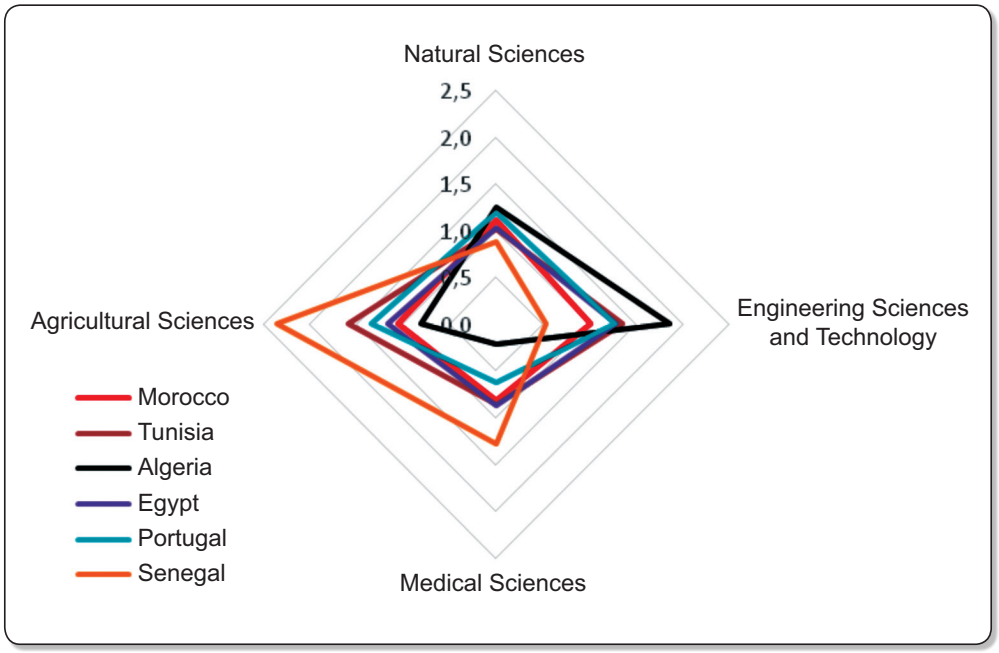
The index of specialization corresponds to the ratio between the global share of the scientific production of Morocco in a given discipline and its global share in all disciplines.

At international level, the index of specialization in 2010 reveals that Morocco is slightly specialized in Natural Sciences (1.12) and Agricultural Sciences (1.06) (see table 10 and graph 12).

**Table 10. Index of specialization of Morocco and of some neighboring selected countries**

| | Morocco | Tunisia | Algeria | Egypt | Portugal | Senegal |
|---|---|---|---|---|---|---|
| Natural Sciences | 1.12 | 1.02 | 1.25 | 1.03 | 1.19 | 0.88 |
| Engineering Sciences and Technology | 1.01 | 1.35 | 1.86 | 1.28 | 1.27 | 0.54 |
| Medical Sciences | 0.81 | 0.85 | 0.22 | 0.87 | 0.62 | 1.28 |
| Agricultural Sciences | 1.06 | 1.59 | 0.81 | 1.17 | 1.34 | 2.35 |

*Sources Thomson Scientific ; IMIST-CNRST*




**Graph 12. Global share of Morocco's citations (regional comparison)**

## Part of Morocco in the co-publications with other countries (2011)

The part of co-publications of Morocco with another country, in all international publications of Morocco, is given for the first 40 partner countries (table A10 in annex): 33.6% of the publications are

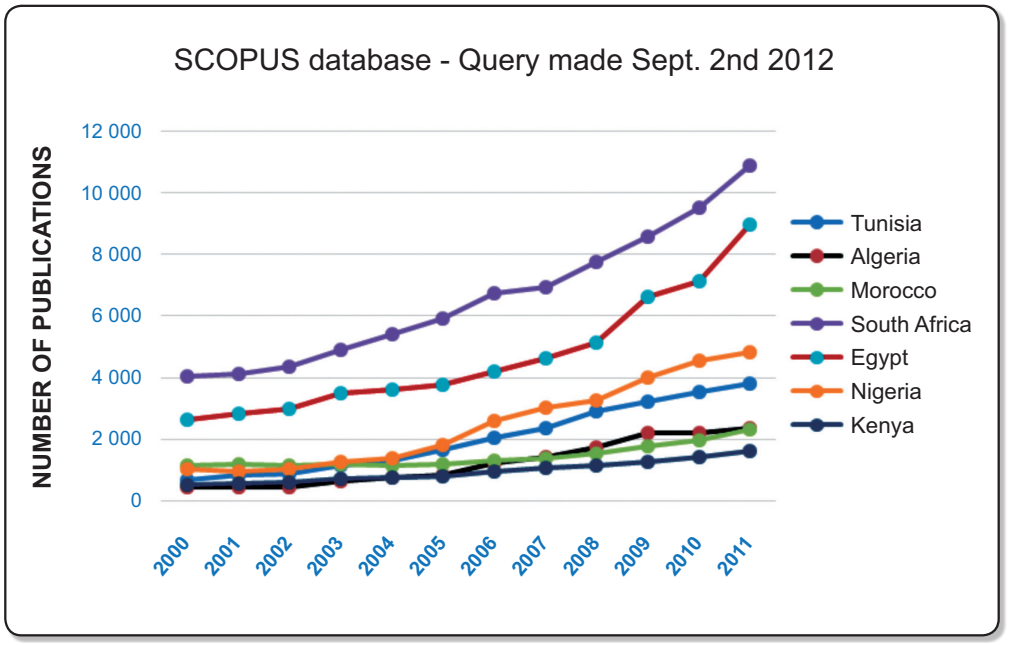
co-authored with at least one French team; France remains the first scientific partner of Morocco in 2011 (see table 23 in annex), Spain, second with 10.05% of co-publications in 2011, followed by USA (5.07%) and Italy (4.06%).

## C-5. Scientific production in SCOPUS database

The analysis of the situation of scientific production in SCOPUS database – which is very important in terms of journals' number (about 20,000 journals) than WOS database (less than 10,000 journals) – gives slightly different results, but the ranking of Morocco in Africa (6th) remains the same. According to SCOPUS, Morocco exceeds 2,000 publications per year (2012 data) (tables 11 and 12, graphs 13 and 14).

**Table 11. Scientific production in SCOPUS database and comparison with a few African countries**

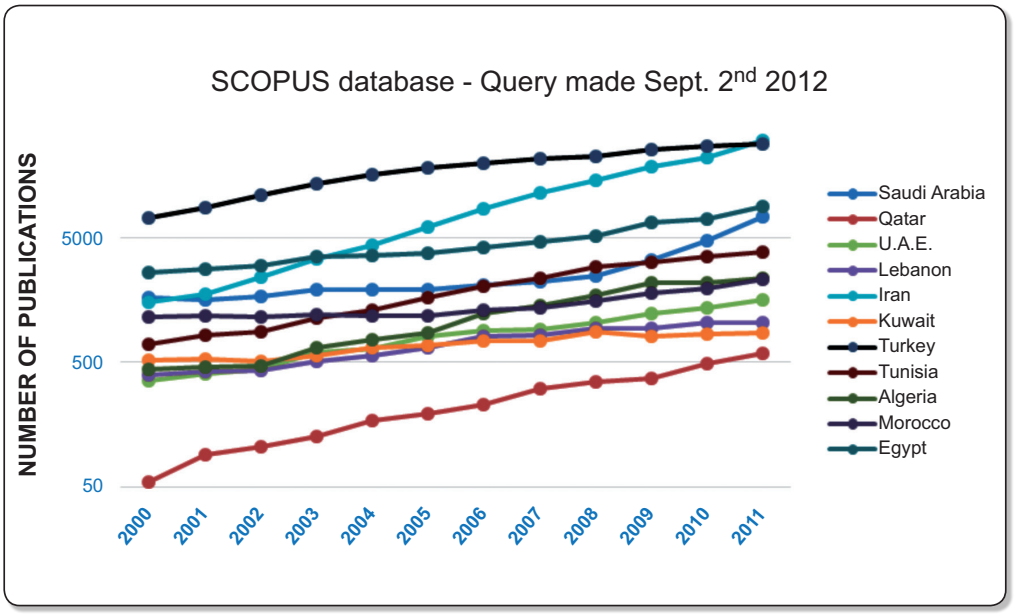
| | | Countries | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Tunisia | Algeria | Morocco | South Africa | Egypt | Nigeria | Kenya |
| years | 2000 | 692 | 441 | 1,147 | 4,028 | 2,653 | 1,019 | 540 |
| | 2001 | 828 | 454 | 1,178 | 4,114 | 2,823 | 952 | 563 |
| | 2002 | 882 | 464 | 1,153 | 4,337 | 2,984 | 1,049 | 614 |
| | 2003 | 1,137 | 654 | 1,197 | 4,900 | 3,513 | 1,260 | 735 |
| | 2004 | 1,322 | 755 | 1,171 | 5,415 | 3,620 | 1,395 | 761 |
| | 2005 | 1,668 | 854 | 1,189 | 5,912 | 3,773 | 1,800 | 818 |
| | 2006 | 2,041 | 1,234 | 1,303 | 6,741 | 4,179 | 2,591 | 952 |
| | 2007 | 2,361 | 1,428 | 1,380 | 6,925 | 4,636 | 3,022 | 1,073 |
| | 2008 | 2,908 | 1,723 | 1,544 | 7,747 | 5,148 | 3,254 | 1,149 |
| | 2009 | 3,216 | 2,190 | 1,788 | 8,583 | 6,611 | 3,999 | 1,270 |
| | 2010 | 3,534 | 2,200 | 1,967 | 9,521 | 7,147 | 4,562 | 1,419 |
| | 2011 | 3,824 | 2,352 | 2,323 | 10,862 | 8,969 | 4,818 | 1,622 |




**Graph 13. Number of publications in SCOPUS database**

**Table 12. Scientific production in Morocco in SCOPUS database and comparison with a few arab countries**

| years | Countries | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Saudi Arabia | Qatar | U.A.E | Lebanon | Iran | Kuwait | Turkey | Tunisia | Algeria | Morocco | Egypt |
| 2000 | 1,654 | 54 | 358 | 396 | 1,515 | 524 | 7,306 | 692 | 441 | 1,147 | 2,653 |
| 2001 | 1,574 | 90 | 404 | 418 | 1,749 | 535 | 8,680 | 828 | 454 | 1,178 | 2,823 |
| 2002 | 1,691 | 105 | 438 | 432 | 2,442 | 514 | 10,938 | 882 | 464 | 1,153 | 2,984 |
| 2003 | 1,935 | 126 | 601 | 512 | 3,429 | 563 | 13,499 | 1,137 | 654 | 1,197 | 3,513 |
| 2004 | 1,918 | 170 | 638 | 570 | 4,393 | 650 | 16,139 | 1,322 | 755 | 1,171 | 3,620 |
| 2005 | 1,937 | 193 | 805 | 659 | 6,105 | 687 | 18,216 | 1,668 | 854 | 1,189 | 3,773 |
| 2006 | 2,109 | 229 | 895 | 815 | 8,608 | 739 | 20,071 | 2,041 | 1,234 | 1,303 | 4,179 |
| 2007 | 2,211 | 309 | 916 | 819 | 11,476 | 739 | 21,573 | 2,361 | 1,428 | 1,380 | 4,636 |
| 2008 | 2,474 | 352 | 1,033 | 942 | 14,450 | 878 | 22,424 | 2,908 | 1,723 | 1,544 | 5,148 |
| 2009 | 3,290 | 369 | 1,225 | 936 | 18,613 | 814 | 25,479 | 3,216 | 2,190 | 1,788 | 6,611 |
| 2010 | 4,715 | 493 | 1,373 | 1,035 | 22,112 | 841 | 27,099 | 3,534 | 2,200 | 1,967 | 7,147 |
| 2011 | 7,383 | 585 | 1,605 | 1,052 | 30,483 | 869 | 28,639 | 3,824 | 2,352 | 2,323 | 8,969 |




**Graph 14. Number of publications in SCOPUS database**

## D. Technological development

The technological development is first appreciated by the number of trained engineers and technicians and by the effort paid to technological innovation. The number of registered patents and the valorization of manufacturing products of high technology concretely highlight the contribution of the R&D in the technological innovation.

### D-1. Training of engineers and technicians

**- Engineers training**

The training of engineers is defined following several requirements related to scientific and technical progresses, evolution of enterprises' needs, diversification of the job market and societal demand. The engineer's job has to be defined within this context and which is inevitably evolutionary.

The openness of the country on the external environment presents, to our engineers and technicians, new challenges with the aim of defying external markets or facing up the competition from

foreign firms. Such challenges need multidisciplinary structures, with efficient and experienced staff, able to handle and to face the foreign competition by conceiving appropriate innovative solutions. The speech of His Majesty King Mohammed VI, on July 30th, 2010, at the occasion of the Throne Feast, focused on the importance of this issue and the necessity to "take courageous decisions to ensure the suitability of the scientific, professional and technical training, with the requirements of the modern economy and the promotion of scientific research and innovation, as well as the imperatives of the integration within the economy of the knowledge and communication society".

The insufficiency of the number of engineers in terms of training weighs a lot on the capacities of the technical supervision of the industrial and commercial sector. In 2006, the government launched a program for the training of 10,000 engineers per year, by 2010. According to the Ministry of Higher Education, this objective was effectively reached. In 2010, 10,600 engineers or as-assimilated engineers were trained; among these only 4,000 were graduated from public engineering schools (without taking into account Moroccan graduates trained abroad and who are of about 300). The Moroccan private sector contributed with 2,000 trained engineers, representing 20%. The remaining 4,300 are composed of as-assimilated engineers. These are students who obtained during their academic education a bachelor diploma or a master in faculties of sciences and technologies (2,900 persons), and specialized master in faculties of sciences (800 graduates). Additionally, there are 600 diplomas obtained through framework agreements. The as-assimilated engineers are trained within 54 institutions.

If we refer to 2010 data, there are about 10,600 students enrolled in different branches of engineering; representing barely 2.4% of all enrolled students in higher education at national level (table 14). Within the same context at international level, the comparison with countries of similar or higher level of development shows that Morocco has a significant delay in terms of engineers' training (indicator that highlights the number of engineers for 10,000 inhabitants (table 13).

**Table 13. Number of engineers per 10,000 inhabitants**

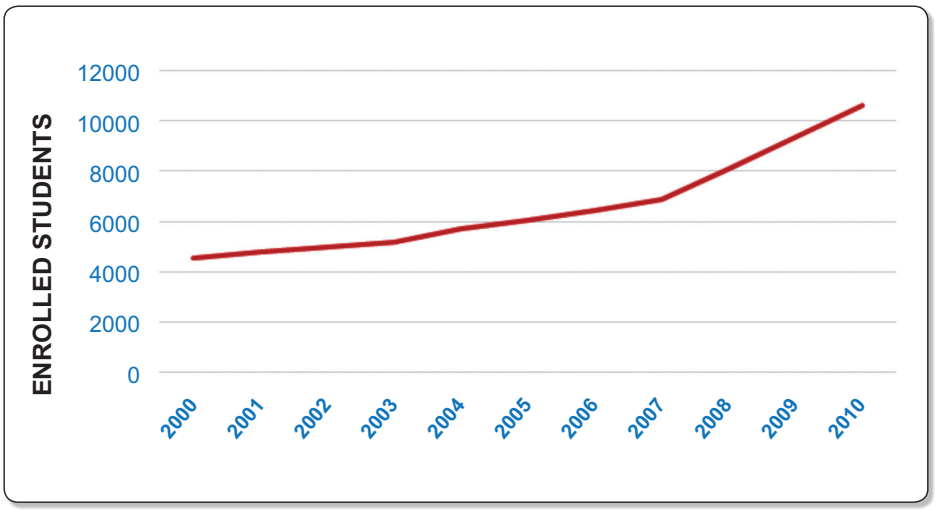
| **Morocco** | Tunisia | Libya | Iraq | Jordan | France | Sweden | Japan |
|---|---|---|---|---|---|---|---|
| **6.73** | 8.75 | 20 | 24 | 40 | 64 | 380 | 540 |

There are presently 21 public specialized schools of engineering, 10 of which are within the universities and 11 under the office of executive training and technical ministries (agriculture, energy and mines, industry and commerce, public works…). Among the first ones, we quote Mohammedia School of Engineering (Ecole Mohammedia d'Ingénieurs: EMI), National School of Electricity and Mechanics (Ecole Nationale Supérieure d'Electricité et de Mécanique: ENSEM, Casablanca), National School of Computer Science and Systems Analysis (Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes: ENSIAS, Rabat) and Graduate School of Arts and Crafts (Ecole Supérieure des Arts et Métiers: ENSAM, Meknès) that recruit following the national general competition ; 7 institutions like National School of Applied Sciences (Ecole Nationale des Sciences Appliquées : ENSA) that recruit right after high school for a 5-year studies. As for institutions of executive training, we can find the Mohammed VI International Academy of Civil Aviation (Académie Internationale Mohammed VI de l'Aviation Civile : AIAC), Hassania School of Public Works (Ecole Hassania des Travaux Publics : EHTP), National School of Mineral Industry (Ecole Nationale de l'Industrie Minérale: ENIM), National Institute of Posts and Telecommunications (Institut National des Postes et Télécommunications: INPT), Higher Institute of Commerce and Business Administration (Institut Supérieur du Commerce et d'Administration des Entreprises: ISCAE) and National Institute of Statistics and Applied Economics (Institut National de Statistique et d'Economie Appliquée: INSEA). There are also two institutions of military training, notably the Royal Air School (Ecole Royale de l'Air: ERA) and Royal Naval School (Ecole Royale Navale: ERN), and three institutions of agricultural training: National School of Agriculture of Meknes (Ecole Nationale d'Agriculture de Meknès: ENAM), National School of Forestry Engineering (Ecole Nationale Forestière d'Ingénieurs: ENFI) and Agronomic and Veterinary Institute Hassan II (Institut Agronomique et Vétérinaire Hassan II: IAV Hassan II).

Between 2000 and 2010, the number of students enrolled in engineering evolved from 4,541 to 10,628 (table 14 and graph 15), indicating an evolution of 134% during the decade.

**Table 14. Evolution of the number of students enrolled in engineering schools between 2000 and 2010**

| Type of institution | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Changes (%) 2000/2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Architecture Urban planning | 461 | 460 | 444 | 456 | 477 | 515 | 550 | 558 | 554 | 555 | 583 | 26 |
| Agriculture, Forestry and Fisheries | 642 | 637 | 635 | 657 | 640 | 623 | 754 | 783 | 871 | 957 | 952 | 48 |
| Engineering Sciences and Technology | 2,645 | 2,819 | 2,956 | 3,080 | 3,513 | 3,703 | 3,890 | 4,274 | 5,136 | 6,127 | 7,217 | 173 |
| Information Technology and Communication | 793 | 887 | 938 | 956 | 1,094 | 1,222 | 1,261 | 1,279 | 1,548 | 1,727 | 1,876 | 136 |
| Total | 4,541 | 4,803 | 4,973 | 5,149 | 5,724 | 6,063 | 6,455 | 6,894 | 8,109 | 9,366 | 10,628 | 134 |
| *Sources : MESRSFC (DEP – DFC) - Ministères techniques* | | | | | | | | | | | | |




**Graph 15. Evolution of the number of students enrolled in engineering schools between 2000 and 2010**

### - Training of senior technicians

The number of students preparing a diploma of senior technician has increased from 12,245 in 2000 to 79,940 in 2010, which represents an evolution of more than 553% (table 15). They are trained essentially in BTS, EST and post-high school professional training (public and private).

**Table 15. Number of students preparing a diploma of senior technician between 2000 and 2010**

| Type of institution | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Changes (%) 2000/2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Higher Ed. Prof. Ed | 9,004 | 10,619 | 12,825 | 16,776 | 23,966 | 31,663 | 40,090 | 50,697 | 59,652 | 67,176 | 71,745 | 697 |
| BTS | 818 | 961 | 1,287 | 1,762 | 1,747 | 1,944 | 2,038 | 2,080 | 1,970 | 2,003 | 2,302 | 181 |
| EST | 2,432 | 2,545 | 2,750 | 2,889 | 2,999 | 3,160 | 3,503 | 4,189 | 4,851 | 5,126 | 5,901 | 143 |
| Total | 12,245 | 14,125 | 17,476 | 21,427 | 28,712 | 36,767 | 45,631 | 56,966 | 66,473 | 74,305 | 79,940 | 553 |

*Sources : MESRSFC (DEP – DFC) - Ministères techniques*

## D-2. Patents

In 2010, about one thousand patents were registered at the Moroccan Office of the Industrial and Commercial Propriety (Office Marocain de la Propriété Industrielle et Commerciale: OMPIC).

Over the 1,007 patents registered at the OMPIC, 856 are of foreign origin, and 151 are Moroccan (see table 16).

Moroccan universities registered 25 patents in 2008 and 41 in 2010.

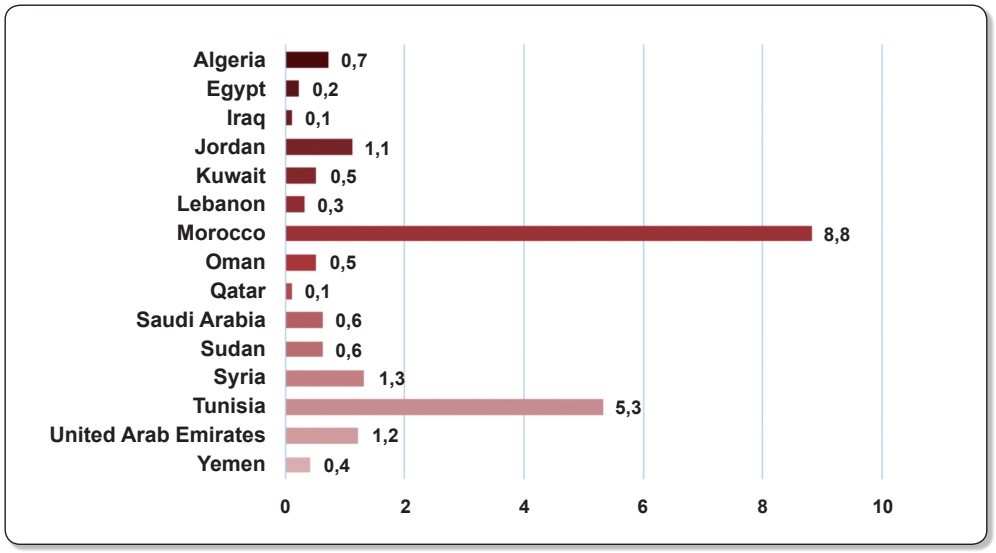
**Table 16. Number and origin of patents registered at OMPIC**

| | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % | Number | % |
| **Moroccan origin** | 178 | 19.56 | 162 | 17.38 | 178 | 17.61 | 135 | 15 | 151 | 15 |
| **Foreign origin** | 732 | 80.44 | 770 | 82.62 | 833 | 82.39 | 794 | 85 | 856 | 85 |
| **Total** | **910** | | **932** | | **1,011** | | **929** | | **1,007** | |

*Source : OMPIC*

## D-3. Production of high technology

According to UNESCO report on science, published in 2010 (see graph 16), Morocco is ranked first among the Arab countries in terms of the percentage related to manufacturing of high technology products with respect to the total exportations.




Source : rapport UNESCO (2010)

**Graph 16. Part in the global exportations of exported manufacturing products**

## D-4. Development of ITC (Information and Communication Technologies)

The penetration level of information and communication technologies is considered as an indirect indicator for the technological evolution of a country.

By the end of 2010, the number of Moroccan subscribers to the landline reached 3.7 million instead of 3.5 million in 2009. At the end of 2011, the number of mobile phone subscribers exceeded 36 million, whereas internet users reached 16 million and is continuously progressing:

- By the end of 2011, the number of internet subscribers reached 3 million. The 3G mobile internet dominates the market with 73.2% of the total number;
- In 2010, the rate of personal computers' equipment in houses was of 34%;
- The number of domain names ".ma" reached 38,000 by the end of 2010, instead of 34,008 in 2009; which represents an increase of 11.8%.

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# Chapter II

# FOR THE REVIVAL OF SCIENTIFIC AND TECHNICAL RESEARCH IN MOROCCO: CHALLENGES AND OPPORTUNITIES



## A. Challenges

Morocco has chosen to open its economy and to find new opportunities for its production and thus gain new market shares for its development. To this effect, the country has to face political, economic, social and environmental challenges; it needs a solid technological and scientific base, on which it can build a modern and competitive economy, able to face the challenges of globalization.

The rapid changes that have recently occurred require proactive actions to address the national and international challenges and issues and find the corresponding appropriate solutions.

- **At the international level,** the scientific community has to face some major challenges related to security and peace, food, climate change, global warming, sustainable development, natural resources depletion (water, row materials), and sustainable supply of energy. These challenges are not extraneous to the concerns of Morocco, which, similarly to other countries, has to integrate them into its scientific and technological policy.

- **Actually, these challenges are for Morocco threefold :**

**- *Social:***

The new Moroccan constitution emphasizes on the emergence of a cohesive society that puts human beings at the center of its public political concerns, and considers the wellbeing of citizens as the ultimate objective of the state's actions. In such a society project, scientific research, in particular research in Social Sciences, has a prominent role in response to the society's needs.

**- *Political:***

The principles and options stated in the Moroccan constitution in terms of promotion of democracy, liberties, equal opportunities, good governance, transparency, and sustainable development cannot be realized without studies and research and scientific evaluation of the results of public policies.

**- *Economical:***

Since its independence, Morocco has opted for openness and freedom of enterprise. It has adapted to globalization by realizing important structural reforms (financial and banking, customs duties, paving the way for privatization and concessions, fiscal reforms). Morocco was the first non-European country to sign an important association agreement with the European Union (UE) and tries to strengthen its trade relations with the EU thanks to the progressive establishment of a free trade area. It has also signed free trade agreements with more than 34 countries, notably United-States of America, the countries of the Agadir agreement (Tunisia, Egypt, Jordan, Turkey), while negotiations are under progression with Canada and some countries of Southern America.

Such a policy of economic openness, whose corollary is the reinforcement of a fragile competitiveness, as well as the necessity to diversify the national offer, associated with the great challenge of adaptation to international standards of production and quality, cannot succeed without research and innovation; an important development lever for short, medium and long terms.

The corner stone of this strategy for the development of scientific research and innovation concerns primarily the Highly Qualified Human Resources and competencies in adequate number and qualifications. These are prominent requirements for the success of such a strategy, which is often less linked to the available financial and material means than the quality of researchers, engineers, executives and technicians to be trained and perfected.

## B. Sectorial development plans: Role of scientific research and technological innovation for their implementation

Sectorial development plans have been implemented by the public authorities since 2000 (see table A11 in annex), to generate sustainable economic growth, job creation and better competitiveness. This type of development is characterized by an innovative approach of public-private partnership, where the private sector participates in the development of strategies and sectorial policies as well as projects' financing. This allows refocusing the role of the state on its regulatory prerogatives.

These plans for the modernization of traditional sectors such as agriculture, fisheries and mining, and the development of innovative sectors such as infrastructure projects, renewable energy sources, logistics, automotive industry, aeronautics and services of high added value through which Morocco offers competitive advantages.

- It is the case of the "Green Morocco: Maroc Vert" plan whose objectives concern, on one hand, the agro-ecological characterization of sites and their agricultural capacities, as well as the knowledge of natural resources, their preservation and the sustainable management of soil, water and biodiversity, and, on the other hand, the upgrade of the various sectors of food production and the increase of their competitiveness. The study of production systems and socioeconomic and institutional environments is also part of the plan, in addition to the development of appropriate technologies. In this context, the national system of

agronomic research is being entirely structured to accompany the "Green Morocco" Plan, notably in the fields of the agro-ecological characterization of the environment and the upgrading of two streams of the plan, namely modern agriculture and solidarity agriculture.

- The "Azur" Plan aims at tripling the capacity of touristic accommodations, promoting tourism as a source of income, and insuring a sustainable and responsible tourism.

- The "Halieutis" Plan aims at insuring a sustainable exploitation of fishery resources, enhancing the competitiveness, performances and the quality of the fishing industry. It is intended within this context to develop an inventory of fishery resources and a classification of the species exploited in Morocco. Thus, an integrated information system of fisheries has to be established.

- The "Energy" Plan, notably with the construction of five centrals of solar energy conversion, whose objective is to reduce the national dependence on imported oil with a target of producing 42% of Morocco's needs in electricity from renewable energy sources by 2020. This plan includes measures aiming at promoting renewable energy resources, protecting the environment through use of clean technologies, improving the energy efficiency in the production chain and of buildings and services, increasing the production performances and energy distribution, reducing the impact of transport on energy consumption, facilitating investments, and promoting best practices and responsible behaviors in terms of energy consumption.

- On industrial level, the "Emergence" Program encompasses new niches such as offshoring, automotive industry and aeronautics, electronics, agribusiness, seafood products, textile, and industrial crafts. Thanks to this plan, Morocco seeks to attract a large number of foreign investors.

**The legitimate ambitions of these sectorial development plans would become a reality and would yield the expected results, notably in terms of competitiveness, only if scientific research and innovation are the engines of the strategy, and only if their implementation is ensured through the training of highly skilled human resources in sufficient number. Indeed, research and innovation contribute not only to attract investors, but also to integrate them within the national economic structure through technology transfer. Such a proactive strategy would avoid delocalization and sustain these activities in Morocco. Scientists and researchers have a prominent role in the success of these plans (table A11 in annex).**

The articulation of these sectorial development plans and the national strategy for scientific research & development by 2025, conceived by the governmental authorities in charge of research had led to the identification of national priorities related to the following areas:

- Agriculture in harsh conditions
- Improvement of quality of life
- Knowledge, preservation and valorization of natural resources
- Socioeconomic and cultural development
- Information sciences and communication technologies
- Innovation and competitiveness of enterprises
- Risk management
- Biotechnologies

**The implementation of the major projects that constitute the sectorial development plans shows that the research should be focused on the society's priorities and should take into account the socio-economic strategic plans of the country. Such a research, which is for the service of the society, needs to strongly involve universities and research institutions that currently have the competencies and scientific and technical platforms that can scientifically support the implementation and the development of the different national sectorial plans.**

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## Chapter III

# THE THREE KEYS FOR THE REVIVAL OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

To handle the shortcomings and weaknesses described in the first two chapters of this report and place the Moroccan scientific and technical research on a sustainable bases that comply with the international standards of quality, the decision-makers policy and actions should deal with three major axes that would likely lead to the revival of the national research system::

- ***Training and mobilization of human resources and competencies***
- ***Boosting the national research system and implementing a more efficient governance***
- ***Strong review of the education and training system and the development of science and technology education and the dissemination of scientific culture.***

# Key axis 1

## Training and mobilization of human resources and competencies

This is the highest priority for boosting and reviving the scientific and technological research in Morocco. It therefore requires urgent decisions within a long-term strategy and a rigorous planning. Indeed, by the end of this decade, more than 800 faculty members will be illegible for retirement each year, while the number of students enrolled in higher education is expected to increase and the present recruitment opportunities are ridiculous because of the lack of training strategy for doctoral students to take over and improve national performances in research.

To cope with this programmed hemorrhage, as well as with an annual increase of about 15-18% in the number of students, to ensure a student-faculty ratio at least equal to the existing one, while taking at the same time into account the additional resources required for the improvement of the education quality, to promote a research that contributes to the success of economic and social policy, it is therefore urgent to implement the following measures:



### **A.** *Measures of extreme emergency*

*A.1. Develop a training plan of more than 15,000 faculty members by 2025*, covering all scientific fields, and taking into account the future needs of a high-quality education and a high-level research. This training should be organized, controlled and regularly evaluated by the concerned ministry, with the help of a **steering committee**.

*A.2. Accredit, by call for tenders, the best Centers of Doctoral Studies*, amongst those that are well structured, with good mentoring capacity, and which are involved in cooperation agreements with international similar centers. These centers must be engaged to provide high-level training and to comply with the international standards. A contract

between the Ministry and the Centers of Doctoral Studies would ensure the allocation of resources, and compliance with international standards in terms of training. This training for and through research should help develop skills in communication and scientific writing, promote language proficiency, and improve university education faculties as well as didactic innovation.

*A3. Promote international mobility of PhD students*, enabling them to work in important foreign laboratories and research structures, and integrate the international scientific community.

## **B.** *In-depth reform of the faculty status*

*The current status of faculty members allows neither a transparent and credible recruitment process, nor the recognition of the most committed and active among them, or fair emulation in terms scientific track records and career promotion that should be based on the performance and track record on individual basis. It is a truly unfair system, which would continue to degrade and marginalize research activities.*

The six following measures are necessary for getting out of this vicious and infernal circle that encourages mediocrity.

*B.1. Establish a more rigorous and transparent recruitment system*, involving national juries and open to the participation of foreign faculty members selected for their competencies and their moral integrity.

*B.2. Implement efficient instruments (such as training of trainers that showed its efficiency in the eightieths and ninetieths)* in order to attract the best students of masters who can devote full time to their training and to their contribution to scientific production.

*B.3. Establish an evaluation system* by the National Agency of Monitoring and Evaluation, provided by the law 01/00, to ensure rank advancement and exceptional career promotions, based solely on the quality of supervision and scientific track records in line with the

international best-practices. Equity and emulation will be preserved in the evolution of the researcher 'career.

*B.4. Implement a system of recognition and significant reward of researchers* whose scientific production and the quality of their works are internationally recognized.

*B.5. Implement appropriate measures to give researchers more mobility at national and international levels* within the framework of their R&D projects and partnerships between universities and enterprises.

*B.6. Encourage the renowned researchers from the Diaspora*, notably those residing in USA and Europe, to contribute to national research. A proactive and attractive policy should be put in place to attract them to Morocco on permanent or contractual bases to participle to the national efforts for research and innovation with the insurance of recognizing and validating their experience, academic tenure and seniority.

## C. *integration of Moroccan research in the global context*

III

*C.1. Identify the conditions and measures permitting to attract international competencies*, within research projects and for a limited period, following the example of American, European and Asian universities. Reserving a quota of positions or equivalent budgetary positions to this category of invited researchers should be provided by regulation and should be taken into account in the evaluation of universities and research centers.

*C.2. Encourage Moroccan researchers to participate in major international research projects*, notably European ones within the framework of the advanced status granted to Morocco by the European Union.

*C.3. Further develop a real cooperation strategy* between Moroccan universities and the best universities and research centers at international level.

# Key axis 2

## Revitalization of the national research system (NRS)

It is about imparting the NRS with a greater coherence, more efficiency for the programs and research projects and increasing the complementarily between various research structures and institutions. It is also necessary to promote trans-disciplinarity and improve monitoring and evaluation of researchers and programs.

The NRS in Morocco was progressively constituted and it is composed of:

a. **Orientation, coordination, planning and funding institutions in charge of developing the national research policy**, such as the Permanent Inter-Ministerial Committee for scientific research and technological development (created by the Decree n°2-00-1019 of 14/07/2001), the ministerial department in charge of scientific research, other Ministries in charge of sectorial research (agriculture, energy, industry, fisheries, environment, mining, water…) and the Hassan II Academy of Science and Technology (created by the law n°1-93-354 of 6/10/1993);

b. **Structures for the promotion of research activities** such as CNRST (national center of scientific and technical research), created by law n°80-00 of 16/08/2001, and which acts through associate research units belonging to universities, and service units as IMIST (Moroccan Institute for Scientific and Technical Information) or UATRS (technical support unit for scientific research), or the high speed network “MARWANE”;

c. **Institutions of execution and implementation of programs and research projects** such as universities (in 2008, 982 structures were accredited, including 445 teams, 25 groups, 488 laboratories, 20 centers of studies and research, and 4 observatories), executive training institutions (such as Ecole HASSANIA – ENI MINERALE, INPT…) public research institutions (such as INR Agronomique, CNESTE Nucléaire, INR Halieutique, IRESEN-Energie, MASCIR-Industry…), private research institutions (such as MANAGEM-mines…).;

d. **Structures of research** valorization such as incubators and techno-parks.

In terms of funding, in addition to the contribution from the state general budget, three funds are dedicated to research: i) the Trust Fund for scientific research and technological development created in 2000, ii) the fund for research and training in the field of new technologies and telecommunications, created in the framework of the law on the liberalization of the telecommunications sector (0.25% of the turnover of companies), and the fund for technological innovation, created by the ministry of industry..

**The role of the Permanent Inter-Ministerial Committee for Scientific Research and Technological Development**, chaired by the head of government, is essential and it is supposed to coordinate all public research and decide for the orientations and for the national priorities in terms of research, as well as for the allocation of research funds. Its missions are particularly important:

- propose to the government the strategy and the necessary orientations for the promotion of the public scientific and technological research;

- ensure the coordination and monitoring of scientific and technological research activities undertaken by the operators belonging to different ministerial departments;

- define the necessary orientations for the development of research projects and programs;

- allocate the resources for different projects and research programs.

Unfortunately, the present NRS is characterized by the juxtaposition of structures that are not effective and without mechanisms of monitoring, arbitration, evaluation and mainly without coordination.

The efficiency of this system has to be considerably improved, by taking inspiration from the six following directing principles:

*D.1. The NRS has to be global and capable* of developing and implementing research strategies that accompany sectorial development plans, preparing national action plans for short and medium terms, defining their priorities and ensuring their funding, their monitoring and their evaluation..

*D.2. The NRS has to be inclusive*, and therefore able to mobilize all research structures, public and private, academic and non-academic, associated with all concerned departments. It has to contribute to the decompartmentalization of research structures, and the emergence of national poles for excellence, regional poles of competitiveness, and thematic poles of education and research.

*D.3. The NRS should be consistent*, avoiding duplication and particularly specifying the missions and actions of the various governing and decision-making bodies. Such coherence and consistency will permit the implementation of R&D projects, their funding and monitoring, with greater efficiency and higher productivity.

*D.4. The NRS must* bring the world of academic research closer to the industrial and economic environment, and thus create synergies between public and private research sectors. It needs therefore the promotion of public-private partnerships, essential to the advancement of research and development of technological innovation.

*D.5. The NRS should finally facilitate the interaction of structures and national* wiprograms with existing counterparts at regional and international levels, which will facilitate the participation in international scientific networks and international funding programs.

*The following urgent measures are recommended to achieve the abovementioned principles:*

**1. Bring into full play the role of the Permanent Inter-Ministerial Committee in charge of scientific research and technological development**, whose department in charge of research would insure the secretariat, in order to boost the action of the committee and make it able to:

***a- prepare a national strategy for promoting research***, for short, medium and long terms, similarly to the other sectorial development plans;

***b- develop multiannual programming laws*** and ensure their follow up by focusing on the national priorities according to the sectorial development plans;

***c- identify and develop new research niches***, for example in biotechnologies, genomics, material sciences, nanotechnologies, renewable energies, imaging and health sciences…;

***d- improve public funding for research and its sanctuarisation***, for instance by adopting incentive fiscal measures that encourage R&D and innovation as well as partnerships between private and public sectors (Provision for R&D, research-credits, venture capitals for technological innovation projects, programs of public-private research, etc…);

***e- ensure, in accordance with the decree instituting the Permanent Inter-Ministerial Committee, the management and repartition, according to priorities, of the available funds in the trust account for scientific research and technological development.*** The same applies to the funds for research and training in telecommunications, provided by the law 24-96 concerning the liberalization of this sector.

**2- Establish a proactive policy for partnership and networking** at regional and international levels.

**3- Participate actively in the development of policies on training of** highly qualified human resources, on the creation of poles of competencies, of partnerships and of networking among the research actors.

**4- Put in place the appropriate mechanisms for recognition of competencies and for the rewarding of excellence in scientific and technological research**, notably by:

- **creating the National Evaluation Agency** provided by the Law 00/01, and which is in charge, thanks to the competencies and objectivity of its experts, of the evaluation of the activities and works of researchers in public research institutions, belonging or not to universities. The agency is called to regularly publish the ranking of universities and research centers, based on the evaluation of their activities and their track records. This will also distinguish the most active and productive researchers;

- strengthening of the autonomy of the university with a **profound revision of the law 00/01**, taking into account the experience of the last twelve years, and ensuring:

  **a. the introduction in the law 00/01 of a chapter on academic research**, to eliminate any obstacles or gaps that currently hinder the promotion of scientific research, the mobilization of researchers and the rational management of their recruitment and promotion;

  **b. the enlargement of the universities autonomy** allowing them ***to manage their human resources in accordance with the international standards*** by adapting the management unities to realities and efficiency imperatives, involving all stakeholders through the reduction in the composition of the university council members and creation of scientific council open to representatives from socio-economic environment, and in charge of defining the major orientations in terms of training and research;

  **c. the adoption of management practices in line with the international** standards that put the qualities and capacities in training and research at the heart of the requirement and promotion policies: specify the role of scientific commissions within institutions and universities such that they will only deal with questions related to the definition of university scientific policies, academic programs, training curricula, evaluation and promotion of researchers by the National Evaluation Agency;.

**d. the adoption of a financial control system adapted to** the research activity and to the imperatives of funders, with a posteriori certification of accounts instead of the current rigid and bureaucratic a priori control;

**e. the implementation of favorable conditions** for creation, functioning and development of incubators and spin-offs through public-private partnership.

**f. the encouragement of consortia between universities and research** institutions within the framework of regional poles of education and research (PRES), as well as the emergence of clusters involving, through R&D programs, universities and innovation institutions. This requires clear policy regarding the creation of such consortia and their funding.

# Key axis 3

## Science Education and Scientific Culture Dissemination

In general, culture is an important tool for the development of a knowledge-based society. It is a sign of democracy and progress and its appropriation by the society enables the understanding of our environment and the evolution of the world. His Majesty King Mohammed VI, emphasized the importance of culture in his speech given of August, 20th, 2012, at the occasion of the 59th anniversary of the King and People's revolution day:

"Culture is nowadays a fundamental lever for creation, innovation, spiritual resourcing and affirmation of national personality. It is the catalyst that boosts our society, a society proud of its plural tributaries and its secular civilization, and of its commitment for diversity and openness to the world".

Scientific component of the general culture is necessary for every society that wants to understand, master and develop technologies that are increasingly complex and not only essential to its development but that become also of current use for the training of citizens.

Moreover, the scientific approach, based on observation – hypothesis – experimentation – simulation (if possible) – and validation or invalidation of the formulated hypotheses, is not only restricted to scientists; it is at the heart of the functioning and the evolution of societies. It influences the individual, familial or collective decisions, and enables also to make wise choices in terms of public governance.

In this context, there is a paradoxical situation in Morocco: on the one hand, the country needs technicians, engineers, researchers and scientists to support the implementation of its sectorial development plans (Green Morocco, Emergence Plan, Morocco Numeric Plan, Azur Plan, Halieutis Plan, Energy Plan…) and base a part of its economy on knowledge and skills; and on the other hand, there is no infatuation of students for scientific and technical fields. This situation, which is also present in other countries, has undoubtedly several causes, but in Morocco, it is exacerbated by the

lack of the dissemination of scientific culture among young students and their parents, as well as in the entire society.

Furthermore, a deficit in terms of logical reasoning and scientific rationality may lead to irrational and dangerous behaviors or stands. It is therefore essential to promote and expand scientific culture within the Moroccan society. To this end, the Hassan II Academy of Science and Technology recommends:

***a- Making the scientific and technical culture a key factor for regional and national development:***

- *Systematic dissemination of scientific culture,* notably by the Ministries of Higher Education, Scientific Research and Executive Training; of National Education; of Culture; and of Industry and New Technologies. In addition, joint actions should be carried out with the Ministries of Health; of Agriculture and Maritime Fisheries; of Energy, Mines, Water and Environment, and of Tourism.

- *Creation and/or development of privileged venues for dissemination of scientific culture* in different regions of Morocco, such as Science Museums, Science Cities, Scientific Parks, Aquariums, Planetariums and "youth and science" Days.

- *Encouragement of the scientific journalism,* which is almost inexistent in Morocco, and promotion of scientific and technological programs.

***b- Use of the scientific method to generate, acquire and disseminate knowledge***

- In his speech given on August, 20th, 2012, His Majesty King Mohammed VI stressed: "*it is about moving school from a space organized on an a logic essentially focused on memory storage and accumulation of knowledge, to a space, where the training of a critical thinking and intelligence stimulation prevail for a firm insertion within the society of information and communication*". Therefore, there is a need to restore education by developing, among pupils and students, the scientific curiosity, reasoning and critical and deductive method, which are the bases of the scientific

culture; the ultimate goal being the development of persons able of observing, reasoning and making deduction from the established facts. This prepares citizens to actively participate in the creativity and innovation that generate technological development. This approach naturally leads to empower the experimental method in education, such as the experience “hands on”, implemented in many countries..

**Therefore, it is strongly recommended:**

- to organize trainings and pedagogical workshops for professors in order to make them familiarized with the scientific and experimental method, such as the experience of “Youth and Science” Days, initiated by the Academy;

- to encourage schools to organize for their pupils visits in industrial institutions and research laboratories, in order to familiarize them with science and technology from their early age, and attract them toward scientific careers. The increase in pedagogical activities in natural sites will strengthen the sense of observation and analysis of facts;

***c- to introduce scientific, oral and written communication in high schools as well as in university curricula and during research training (Master and Ph.D);***

**d- to adopt a linguistic policy that aims at facilitating the access to sciences and technologies and the mastering of foreign languages,** particularly French and English. Article 5 of the Moroccan constitution stress the following: “similarly, the State shall ensure the coherence of the national linguistic and cultural policy, and the learning and mastery of the most used foreign languages in the world, as tools of communication, integration and interaction with the knowledge society and of openness on different cultures and modern civilizations”. It is therefore imperative to improve the language skills of all students and pupils in order to help them to gain access to knowledge and technology in the best conditions, and also to better interact with other cultures.

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# Conclusion

As it did in May 2009, the Hassan II Academy of Science and Technology, in full accordance with its missions, alerts once again all concerned authorities on the state of scientific and technological research in Morocco, as well as on the urgency to boost it by strong and sustainable measures.

Firstly and based on the most recent statistical data, Morocco lags far behind with respect to other neighboring or comparable countries, in terms of research staff number (of all categories), mentoring and supervision rate of students and young researchers, number of awarded PhD degrees and resources allocated to research-development (0.73% of the gross domestic product – GDP – in 2010).

Secondly and always based on drawn data from reliable sources, the national track record in terms of scientific dissemination – publications, scientific books and patents – declined during the last decade with respect to similar countries: Morocco is presently ranked 6th in Africa for its scientific track record, whereas 10 years ago, it was ranked 3rd. Out of the 1007 patents in 2010, registered in the Moroccan Office of Industrial and Commercial Property, 856 were of foreign origin, and only 151 were Moroccan (including 41 registered by universities).

Such situation could cause serious harm to the development of the country, which tries to firmly open its economy on the world, as evidenced by the various free trade agreements and the advanced status of association with the European Union. This could also jeopardize the implementation of the ambitious sectorial development plans, which aim at improving the competitiveness of Moroccan industries by investing in technological innovation and ensuring the presence in growth areas such as aeronautics, automotive industry, electronics, information and communication technologies and offshoring.

All these development plans and the major economic and technological projects require the contribution of R&D and innovation. Therefore, it is urgent, as emphasized by many national and international reports, to redefine and implement policies for the medium and long terms, but also to take immediate adequate measures:

**1. Development of a strategy of training for the new generation of researchers, and mobilization of competencies in order to enhance the national scientific production and ensure its quality**. The main objectives are: to train 15,000 faculty by 2025; reform their status, establish an evaluation system based on equity and merit; recognize and reward the national scientific production using international standards; encourage researchers' mobility and the interaction with Moroccan scientists living abroad..

**2. Major reform of the National Research System to make it capable of giving scientific support to the various national sectorial development plans** (Maroc Vert, Azur, Halieutis, Energie, Emergence) and to render it inclusive and coherent for the mobilization of all research structures, elimination of all redundancies and for serious improvement of governance..

A major priority is to bring closer the public research and private sectors : expand, reinforce and tighten the links between the academic and economic worlds with a proactive policy and an effective coordination, provided by the governance bodies of a completely transformed National Research System. It is essential to develop a national strategy for research promotion, under the form of a law of multiannual plans that ensures the respect of national development

priorities, exploration of new research and technological innovation niches, and the improvement of funding and modern management of research activities in public sector..

**3. Improve the quality of science and technology education across all the education curricula**, and particularly encourage experimentation, observation and reasoning to get a good assimilation of knowledge and develop scientific and technical culture. Systematic dissemination of this culture, through educational institutions, universities, research centers and all media, has to largely contribute to the development of Morocco.

Access to science and technology, their mastery through the progress of knowledge and for the development are today closely associated with good knowledge of foreign languages, such as French and English. It is therefore mandatory to improve the learning of these languages and to strengthen the linguistic capacities that are already acquired by all students and pupils.

It will lead to a clear benefit for Morocco in terms of national scientific and technological production, a more effective participation in the global research and will strengthen international cooperation and dialogue and the rapprochement between cultures.

The Hassan II Academy of Science and Technology and all its members hope that this collective work will be carefully examined and followed by concrete actions and urgent measures. They also hope, through this work to respond to the objective set by His Majesty King Mohammed V "*to serve the country and contribute to the development of the global science*".

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# ANNEXES

أكاديمية الحسن الثاني للعلوم والتقنيات
أكاديمية الحسن الثاني للعلوم والتقنيات

| Table A1: Scientific research personnel in 2010 | | | | |
|---|---|---|---|---|
| **Type of institution** | **Number** | | **Personnel** | **Percentage %** |
| Universities | 16 | 72 Faculties<br>34 Schools<br>6 Research Institutes | 27,953 of which are 10,267 faculty and 17,686 PhDs | 75.04 |
| Non-university public institutions of higher education | 63 | | 1354 faculty | 3.63 |
| Private institutions of higher education | 192 | | 512 permanent teachers | 1.37 |
| Public research institutions | 17 | | 4,794 (researchers, engineers, technicians and equivalent staff) | 12.87 |
| Private companies | 239 | | 2,633 (engineers and technicians) | 7.07 |
| **TOTAL** | **618** | | **37,246** | **100.00** |
| *Sources: MESRSFC (DEP – DFC) - Ministères techniques – EPR – R&D Maroc ** | | | | |

***MESRSFC: Ministère de l'Enseignement Supérieur, de la Recherche Scientifique et de la Formation des Cadres (Ministry of Higher Education, Scientific Research and Executive Training),***
***DEP: Direction de l'Évaluation et de la Prospective,***
***DFC: Direction de la Formation des Cadres,***
***EPR: Établissements Publics de Recherche (Structures publiques de recherche finalisée, qui sont davantage centrées sur un secteur ou un objectif socio-économique bien défini (comme l'INRA, l'INRH, le CNESTEN, etc.)***
***R&D Maroc: Association R&D Maroc.***

| Table A2: Distribution of research staff by subject area and quota for women in 2010 | | | | | |
|---|---|---|---|---|---|
| Disciplinary field | Number | | | Percentage (%) | |
| | M+W | W | % | M+W | W |
| Natural Sciences (NS) | 11,954 | 4,439 | 37.13 | 32,09 | 11.91 |
| Engineering Sciences and Technology (EST) | 7,919 | 2,482 | 31.34 | 21.26 | 6.66 |
| Medical Sciences (MS) | 2,001 | 502 | 25.08 | 5.37 | 1.34 |
| Human and social sciences (HSS) | 14,984 | 4,157 | 27.74 | 40.23 | 11.10 |
| Other | 388 | - | | 1,04 | |
| **TOTAL** | **37,246** | **11,580** | **31.09** | **100** | **31.09** |
| *Sources : MESRSFC (DEP – DFC) - Ministères techniques – EPR* | | | | | |

**Table A3: Evolution of the number of enrolled students in graduate studies by field of study**

| Disciplinary field | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | | 2007 | 2008 | 2009 | 2010 | Changes 1997/2010 (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Material and life sciences** | **5,083** | **5,179** | **6,069** | **6,016** | **6,201** | **5,696** | **5,918** | **6,759** | **7,368** | **9,366** | | **12,139** | **12,827** | **13,628** | **15,875** | **+198** |
| Natural Sciences | 4,776 | 4,763 | 5,422 | 5,266 | 5,450 | 4,936 | 5,182 | 5,865 | 6,524 | 7,444 | | 10,286 | 10,730 | 11,139 | 12,807 | **+168** |
| Medical Sciences | - | - | 38 | 144 | 163 | 189 | 219 | 191 | 254 | 1,140 | | 1,052 | 1,454 | 1,544 | 1,920 | |
| Engineering Sciences and Technology | 307 | 416 | 609 | 606 | 588 | 571 | 517 | 703 | 590 | 782 | | 801 | 643 | 945 | 1148 | |
| **Human and social sciences** | **14,939** | **7,846** | **8,981** | **8,317** | **8,523** | **8,830** | **9,523** | **10,869** | **11,842** | **12,567** | | **15,810** | **18,775** | **20,671** | **23,508** | **+57** |
| LSH | | 5,632 | 4,664 | 5,202 | 4,509 | 4,494 | 4,845 | 4,892 | 5,209 | 5,193 | 5,722 | 6,625 | 7,393 | 7,364 | 8,582 | |
| SJE | | 8,590 | 2,734 | 3,019 | 3,090 | 3,227 | 3,202 | 3,831 | 4,834 | 5,802 | 6,324 | 8,525 | 10,635 | 12,554 | 13,995 | |
| SE/EO | | 717 | 448 | 760 | 718 | 802 | 783 | 800 | 826 | 847 | 611 | 660 | 747 | 753 | 929 | |
| **Total** | | **20,022** | **13,025** | **15,050** | **14,333** | **14,724** | **14,546** | **15,441** | **17,628** | **19,210** | **22,023** | **27,949** | **31,602** | **34299** | **39,381** | **+96** |

*Sources : MESRSFC – DEP*

**Table A4: Number of students enrolled in graduate studies (including the master) by field of study and graduate in 2010**

| Disciplinary field | Total | Master | DESA | DESS | DSM | DSMD | Ph.D. | State Ph.D. |
|---|---|---|---|---|---|---|---|---|
| Traditional Education | 416 | 299 | | | | | 117 | |
| Economic Social and Legal Sciences | 13,616 | 7,929 | 441 | 141 | | | 4,494 | 611 |
| Letters and Human Sciences | 8,582 | 3,969 | | | | | 4,109 | 504 |
| Natural Sciences | 10,769 | 4,814 | | | | | 5,459 | 496 |
| Science and Technology | 2,038 | 1,263 | | | | | 766 | 9 |
| Medicine and Pharmacy | 1,808 | 45 | | | 1720 | | 43 | |
| Dental Medicine | 112 | | | | | 112 | | |
| Engineering Sciences | 1,148 | 388 | 41 | 6 | | | 701 | 12 |
| Business and Management | 379 | 269 | 39 | | | | 71 | |
| Science of Education | 513 | 219 | | | | | 294 | |
| **TOTAL** | **39,381** | **19,195** | **521** | **147** | **1,720** | **112** | **16,054** | **1,632** |
| **%** | **100** | **48,74** | **1,32** | **0,37** | **4,36** | **0,28** | **40,76** | **4,14** |

*Sources : MESRSFC – DEP*

| Table A5: Number of awarded Ph.Ds by discipline 2005-2009 | | | | | | |
|---|---|---|---|---|---|---|
| **Disciplinary field** | | **2005** | **2006** | **2007** | **2008** | **2009** |
| **Basic and natural sciences** | Mathematics and Computer Science | 47 | 24 | 57 | 30 | 34 |
| | Physic | 78 | 63 | 90 | 35 | 76 |
| | Chemistry | 75 | 58 | 71 | 40 | 49 |
| | Life Sciences | 89 | 74 | 69 | 60 | 76 |
| | Earth Sciences | 42 | 16 | 35 | 10 | 12 |
| | Other | | | | 32 | 22 |
| **Total** | | **331** | **235** | **322** | **207** | **269** |
| **Engineering Sciences** | | 9 | 9 | 23 | 23 | 30 |
| **Total** | | **9** | **9** | **23** | **23** | **30** |
| **Human and social sciences** | Law | 86 | 121 | 148 | 219 | 107 |
| | Economic Sciences | 18 | 47 | 65 | 166 | 33 |
| | Traditional education | 22 | 13 | 39 | 35 | 9 |
| | Islamic Studies | 50 | 65 | 52 | 33 | 65 |
| | Language | 155 | 190 | 98 | 130 | 84 |
| | Geography | 13 | 36 | 49 | 4 | 13 |
| | History | 17 | 25 | 28 | 17 | 24 |
| | Philosophy, Sociology | 23 | 35 | 12 | | 15 |
| | Educational Sciences | 18 | 9 | 10 | 11 | 27 |
| | Other | | | | 15 | 0 |
| **TOTAL** | | **402** | **541** | **501** | **630** | **337** |
| **ALL** | | **742** | **785** | **846** | **860** | **676** |
| *Sources : MESRSFC - DEP* | | | | | | |

| Table A6: Research staffing and / ratio compared to the population (per thousand) in 2009 | | |
|---|---|---|
| **Country** | **Numbers of researchers (Full Time Equivalent)** | **Researchers per thousand inhabitants assets (EFA)** |
| South Korea | 236 137 | 9,87 |
| Portugal | 45 909 | 8,13 |
| Turkey | 57 759 | 8,02 |
| Spain | 133 803 | 5,88 |
| Czech Republic | 28 785 | 5,54 |
| Tunisia | 19 086 | 5,10 |
| France | 229 130 | 2,35 |
| Romania | 19 271 | 2,01 |
| **Morocco** | **20 703** (2008) | **1,77** |
| Algeria | 27 497 | 1,56 |
| Egypt | 33 516 | 1,26 |
| Senegal | 4 527 | 0,90 |
| *Sources : Institute of Statistics of UNESCO* | | |

| Table A7: Number of students enrolled in higher education in 2010 | | | | |
|---|---|---|---|---|
| **Country** | **Population** | **Number of students** | **Percentage of women** | **Ratio per 1000 inhabitants** |
| South Korea | 49,000,000 | 3,219,216(2008) | - | 65 |
| Romania | 21,400,000 | 1,048,188(2008) | 56 | 49 |
| Czech Republic | 10,500,000 | 416,847(2008) | 56 | 40 |
| Jordan | 6,600,000 | 266,881(2008) | 51 | 40 |
| Turkey | 74,000,000 | 2, 924,281(2008) | 44 | 39 |
| Spain | 46,200,000 | 1,800,834(2008) | 54 | 39 |
| Portugal | 10,700,000 | 373,002(2008) | 53 | 35 |
| France | 63,300,000 | 2,172,855(2008) | 55 | 34 |
| Tunisia | 10,700,000 | 360,122(2008) | 60 | 34 |
| Malaysia | 28,900,000 | 922,239(2009) | 56 | 32 |
| Algeria | 36,000,000 | 1,144,271 | 58 | 32 |
| Egypt | 82,600,000 | 2,488,434(2009) | 43 | 30 |
| **Morocco** | **32,300,000** | **446,948** | **47** | **14** |
| Senegal | 12,800,000 | 92,106 | - | 7 |
| *Sources : Institute of Statistics of UNESCO* | | | | |

| Table A8: Evolution of the number of teachers and researchers in Morocco and other countries | | | |
|---|---|---|---|
| **Country** | **Number of teaching staff** | | **Changes (%) 2005/2009** |
| | **2005** | **2009** | |
| Jordan | 8,251 | 13,613 | 64.98 |
| Algeria | 26,097 | 39,782 | 52.43 |
| Malaysia | 41,871 | 61,253 | 46.28 |
| Turkey | 82,096 | 100,504 | 22.42 |
| Tunisia | 16,671 | 20,049 | 20.26 |
| South Korea | 190,521 | 216,660 | 13.71 |
| Spain | 144,973 | 155,598 | 7.32 |
| Romania | 30,857 | 31,975 | 3.62 |
| **Moroccoo** | **14,416** | **13,909** | **-3.59** |
| Portugal | 36, 773 | 35,380 | -3.78 |
| Czech Republic | 24,298 | 22,306(2006) | -8.19 |
| France | 135,783 | - | - |
| Egypt | 80,658 | - | - |
| Senegal | 1,099 | - | - |
| *Sources : Institute of Statistics of UNESCO* | | | |

| Table A9: Higher education graduates education issued in 2005 and 2009 | | |
|---|---|---|
| Country | Number of graduates | |
| | 2005 | 2009 |
| France | 664,711 | 621,444 |
| South Korea | 607,982 | 595,127 |
| Spain | 298,448 | 310,452 |
| Turkey | 258,858 | 488,803 |
| Malaysia | 202,705 | 206,588 |
| Egypt | - | 416,470 |
| Romania | 156,565 | 310,886 |
| Portugal | 70,023 | 76,567 |
| Czech Republic | 54,341 | 96,207 |
| **Morocco** | **48,162** | **70,780** |
| Algeria | - | 154,838 |
| Jordan | 42,294 | 49,574 |
| Tunisia | 28,565 | 65,630 |
| Senegal | - | - |
| *Sources : Institute of Statistics of UNESCO* | | |

| Table A10: Contribution from Morocco in joint publications with other countries (2011) | | |
|---|---|---|
| **Countries** | **Number of publications** | **%** |
| France | 1,903 | 33.60% |
| Spain | 569 | 10.05% |
| USA | 287 | 5.07% |
| Italy | 230 | 4.06% |
| Germany | 228 | 4.03% |
| Canada | 192 | 3.39% |
| England | 148 | 2.61% |
| Tunisia | 130 | 2.30% |
| Belgium | 112 | 1.98% |
| Portugal | 112 | 1.98% |
| Algeria | 95 | 1.68% |
| Japan | 74 | 1.31% |
| Switzerland | 71 | 1.25% |
| Turkey | 71 | 1.25% |
| Malaysia | 61 | 1.08% |
| Czech Republic | 56 | 0.99% |
| Brazil | 50 | 0.88% |
| People's Republic of China | 47 | 0.83% |
| Netherlands | 46 | 0.81% |
| Greece | 43 | 0.76% |
| Sweden | 43 | 0.76% |
| Egypt | 40 | 0.71% |
| Australia | 37 | 0.65% |
| Russia | 35 | 0.62% |
| Austria | 34 | 0.60% |
| India | 34 | 0.60% |
| Saudi Arabia | 34 | 0.60% |
| Scotland | 32 | 0.57% |
| Taiwan | 32 | 0.57% |
| Pakistan | 31 | 0.55% |
| Denmark | 29 | 0.51% |
| South Africa | 28 | 0.49% |
| Mexico | 27 | 0.48% |
| Hungary | 26 | 0.46% |
| Poland | 26 | 0.46% |
| Norway | 25 | 0.44% |
| Romania | 25 | 0.44% |
| Slovakia | 25 | 0.44% |
| Cameroon | 23 | 0.41% |
| Senegal | 23 | 0.41% |
| *Sources: Thomson Scientific ; IMIST-CNRST* | | |

| Table A11: National Sectorial Development Plans, their purposes and areas of potential R&D | | |
|---|---|---|
| **Sectorial Plan** | **OBJECTIVES** | **Possible R & D Axes** |
| GREEN MOROCCO PLAN | Agroecological characterization, of the environment and its agricultural potential, as well as the knowledge of natural resources, their preservation and sustainable management (soil, water, biodiversity) | • Develop maps of agricultural land use (INRA, IAV, ENA)<br>• Study the impact of climate change on agricultural production (INRA, IAV, ENA)<br>• Prediction of cereal crops (INRA, IAV, ENA)<br>• Conservation and development of plant genetic resources (INRA, IAV, ENA)<br>• Development of integrated pest management in different crops (INRA, IAV, ENA)<br>• Management and conservation of water and soil (INRA, IAV, ENA)<br>• Management, conservation and use of biodiversity<br>• Development of water-saving irrigation techniques |
| | Upgrading various channels concerning one or the other of the two pillars of the Green Morocco Plan (modern agriculture and several agriculture) and increasing their competitiveness (improving productivity, sustainability and exploitation) | • Improved productivity of sheep and goats (INRA, IAV, ENA)<br>• Valuation of products and improved food processing (INRA, IAV, ENA)<br>• Improved productivity and quality of agricultural products<br>• Improved productivity and quality of the vine<br>• Effect of defoliation combined with cyanamide on bud break in the nature and on the production of apple trees<br>• Study of pollination on Almond related types<br>• Contribution to the study of the low cherry production in mid-altitude areas.<br>• Collection, preservation and development of local genetic resources and improvement through varietal introduction<br>• Fight against flooding and flood damage: Gharb, Doukkala, Mohammedia, Grand Casablanca and Tangier Regions<br>• Integrated control against plant diseases.<br>• Search for sources of resistance to cereal diseases<br>• Biological control against nematodes of vegetable plants<br>• Development of methods of biological control against Fusarium wilt of date palm (bayoud)<br>• Identification of sources of resistance against rust lens<br>• Determination of pathogenic variability of the causative agent of rust lentils and beans<br>• Development of genotypes resistant / tolerant to broomrape and / or Botrytis |

| Sectorial Plan | OBJECTIVES | Possible R & D Axes |
|---|---|---|
| Plan Maroc Vert | Studies on production systems and socio-economic and institutional environments as well as on agricultural policies and the analysis of their impact on industries, production systems, farms and natural resources areas. | • Social relations in the adoption of wheat varieties<br>• Profitability of varietal wheat research in Morocco<br>• Study of rural exodus and finding solutions to this problem<br>• Agro- socio- economic study of the palm grove production system<br>• Collection and investigation of sheep farming in the Atlantic and the Middle Atlas agro -pastoral areas<br>• Valuation of barley planning : Substitution of a part of wheat consumption by barley<br>• Economic study of the insertion of the green manure in wheat / maize and wheat systems / fallow in arid and semi-arid regions<br>• Effect of changes in the terms of trade for grain/inputs and legumes/input on the choice of terminology relating to the production of these two commodities<br>• Study the issue of succession in family farms in semi -arid areas<br>• Valuation of forest, steppe and Saharan ecosystems<br>• Forestry policy and socio -economic aspects<br>• Management and sustainable multifunctional forest management<br>• Agroforestry, cork, energy production<br>• Innovation to adapt to the demands and international standards |
| | Coverage of agricultural ecosystems (sub-humid, arid and semi-arid, Oasis, irrigated mountain paths, Saharan and pre-Saharan areas) and production systems (large, small and medium agriculture) | • Stand of barley and efficiency of water use under different cereal rotations and management system of crop residues in semi-arid.<br>• Water conservation in different cereal rotations and system<br>• The effect of applied and residual nitrogen on the wheat biennial rotation with winter chickpea and chemical fallow<br>• Conservation and restoration of soil under conservation tillage and conventional systems in semi-arid environment<br>• The effect of soil moisture on the degradation of herbicides<br>• Long-term effect of phosphorus and potassium on wheat<br>• Residual effect of phosphorus in continuous wheat rotations / fallow wheat.<br>• Collection of fodder and pastoral shrubs in arid, semi-arid and Saharan areas and its industrial use<br>• Fight against desertification and valorisation of tillage and dryland |
| | Dissemination of technologies developed and active and focused participation in various projects and projects initiated under the Green Morocco Plan for greater ownership of the know-how developed. | • New approach to agricultural machinery: Scan the design of agricultural machinery<br>• Adaptation of the ridger drill for sowing sugar beet<br>• Development of a harvester pasture seed<br>• Making a small planter for wheat sowing |

| Sectorial Plan | OBJECTIVES | Possible R & D Axes |
|---|---|---|
| AZUR PLAN | Promote tourism as a source of undeniable income but at the same time ensure sustainable tourism. | • Development and touristic development (site identification and management methods adopted).<br>• Development and identification of attractions for mountain tourism.<br>• Development of rural tourism and eco-tourism.<br>• Development of niche tourism and domestic tourism<br>• Wastewater reuse for irrigation of golf courses, parks and tourist areas<br>• Control of resources leading to saving water and energy in tourism infrastructure |
| HALIEUTIS PLAN | Sustainable use of resources<br><br>Performance and quality of the fishing industry<br><br>Strengthening competitiveness | • Establishment of a comprehensive inventory of national fishery resources<br>• Establishment of an integrated fisheries information system<br>• Oceanographic studies on marine ecosystems<br>• Development of the national aquaculture<br>• Preservation and enhancement of fish stocks and marine ecosystem<br>• Improved knowledge of the biology and ecology of the resources and dynamics of ecosystems<br>• Assessing the impact of climate change on the distribution and abundance of marine species (NHRI)<br>• Impact of climate change study on the structure and functioning of ecosystems (NHRI)<br>• Thorough knowledge of the functioning of coastal marine ecosystems<br>• Mariculture development in all its aspects<br>• Study of climate change and its likely impact on the resources and the coastal zone<br>• Development of marine biotechnology<br>• Thorough understanding of coastal and marine morpho dynamics<br>• Institutional and regulatory mechanisms of coastal occupation and exploitation of living and non-living resources<br>• Developing appropriate actions to traditional activities related to the sea and the requirements of safety and durability<br>• Monitoring the quality and safety of marine shoreline<br>• Study reorganization or modification of fishing practices due to changes in species dynamics |

| Sectorial Plan | OBJECTIVES | Possible R & D Axes |
|---|---|---|
| **ENERGY PLAN** | Security of energy supply and diversification of forms of energy used<br><br>Increased deep offshore oil exploration<br><br>Promoting renewable energy<br><br>Environmental protection and use of clean technologies | • Photovoltaic and thermal solar energy and their applications<br>• Wind energy and its applications<br>• Biomass energy and its applications<br>• Valuation of oil shale<br>• Energy systems: modeling, optimization, design and economy<br>• Materials, nanomaterials and their applications in energy production<br>• Tidal energy |
| | | Two calls for proposals launched in 2012 by the Research Institute of Solar Energy and New Energy (IRESEN)<br>1. InnoTherm I - 20 MDH<br>Solar thermal (Simulation, modeling and architecture and system)<br>2. InnoTherm II - 20 MDH<br>- Support solar technology (components, storage, network).<br>- Application of solar thermal: desalination, cold, steam, solar oven.<br>2013: Integration of photovoltaic and wind power |
| **EMERGENCE PROGRAM** (Industrial Map of Morocco) | Aerospace<br><br>Electronics<br><br>Automobile<br><br>Agribusiness<br><br>Offshoring | • Electronics and microelectronics<br>• Science and numerical engineering<br>• Simulation and Modeling<br>• Industrial control system processes<br>• Nanotechnology and Nanomaterials<br>• Automotive components<br>• Embedded technologies<br>• Preparation, characterization, manipulation of individual nanoscale objects (quantum boxes and wires, nanotubes, supramolecules, etc.).<br>• Elementary components, ultimate components, electronic one electron nanomagnetism spintronics, emitting coherent and incoherent light sources to one photon, molecular electronics and optoelectronics ...<br>• Design, implementation and study of circuits and systems based on components whose properties are related to their nanoscale<br>• Development of new architectures, design and modeling of circuits, interconnection (electronic and optical), addressing and, more generally, the optimization of information transfer<br>• Components and molecular circuits, self-assembly phenomena and self-organization, hybridization circuits<br>• Mathematics in finance, risk management and portfolio<br>• Products, processes and innovative services<br>• Technology transfer<br>• Improvement of industrial competitiveness<br>• Development and integration of new manufacturing technologies, production and control<br>• Environmental impact reduction during the entire life cycle of products<br>• Intelligent production<br>• Market gardening, condiments, herbs and spices and berries<br>• Transformation of «organic» products and dishes<br>• Development of the sector of olive oil, argan oil and orange juice superior<br>• Development platform export |

| Sectorial Plan | OBJECTIVES | Possible R & D Axes |
|---|---|---|
| NUMERIC MOROCCO PLAN | Accessibility of citizens to high-speed internet and access to trade and knowledge<br><br>Reconciliation of the administration to the user needs in terms of efficiency, quality and transparency through the e-government program<br><br>Encouraging the use of ICT by small and medium enterprises<br><br>Development of the sector of information technology. | • Mobile content<br>• Computer Security<br>• Software and web design<br>• Protection of information transmitted over the telecommunications networks<br>• Image processing and speech<br>• Application Development in the field of Computer Telephony Integration (CTI)<br>• Access to «Internet» via Low voltage electrical distribution lines<br>• Development of distance education and distance learning<br>• Technologies related to spoken language and written<br>• Production software and multimedia tools in Arabic<br>• Access, filtering, analysis and information processing<br>• Technologies and engineering for software, systems and services<br>• Technology and application development management and maintenance of telecommunication networks<br>• E-commerce and management system for suppliers and consumers<br>• Flexible methods and tools, mobile and remote |
| TEXTILE INDUSTRY | New materials<br><br>Design | • Textile Engineering<br>• Advanced Textile Materials<br>• Design and mass customization<br>• Textile and Health<br>• Biopolymers nanofibers<br>• Sensory, requirement to successful technical and functional textiles of tomorrow<br>• Nanomaterials sources of innovative applications in the world of technical textiles<br>• The derma-textiles: textile solutions in prevention and treatment of inflammatory skin diseases<br>• Functionalization of textiles: potential of supercritical fluids<br>• Transfer modeling of heat and moisture in the system of protective clothing<br>• Study the performance of protective clothing against the cold<br>• Development of a numerical model to predict the degree of thermal stress associated with protective clothing.<br>• Electrospun nanofibers for medical applications |

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