

Science, technology and innovation in Landlocked Developing Countries, Least Developed Countries and Small Island Developing States

As the Draft Programme of Action for Landlocked Developing Countries for the Decade 2014-2024 (A/CONF.225/PC/L.4) rightly notes, “(s)cience, technology and innovation play a critical role in the alleviation of poverty as well as the rapid development of landlocked developing countries, in particular for achieving structural transformation, improving agricultural productivity, promoting energy access and developing information and communication sectors” and that “(l)andlocked developing countries should promote investment in science, innovation and technology for sustainable development.” Science, technology and innovation is also included as a priority action area in the Programme of Action for the Least Developed Countries for the Decade 2011-2020, which notes that “acquiring new technologies and building domestic capacity and a knowledge base to be able to fully utilize acquired technologies and promoting indigenous capacity on a sustainable basis for research and development are needed to enhance productive capacities in least developed countries. Furthermore, development of this sector should help to bridge the digital divide and technology gap in support of rapid poverty eradication and sustainable development.” Science, technology and innovation are also mentioned as “essential enablers and drivers for sustainable development” in the SIDS Accelerated Modalities of Action (SAMOA) Pathway.

In order to promote investment in science, technology and innovation (STI), policy makers need to know the state of their STI systems in order to establish, benchmark, assess and monitor effective STI policies. As the UN agency responsible for the collection and dissemination of internationally comparable STI data, the UNESCO Institute for Statistics (UIS) maintains a database with research and (experimental) development (R&D) and innovation indicators for all countries in the world.

Research and development

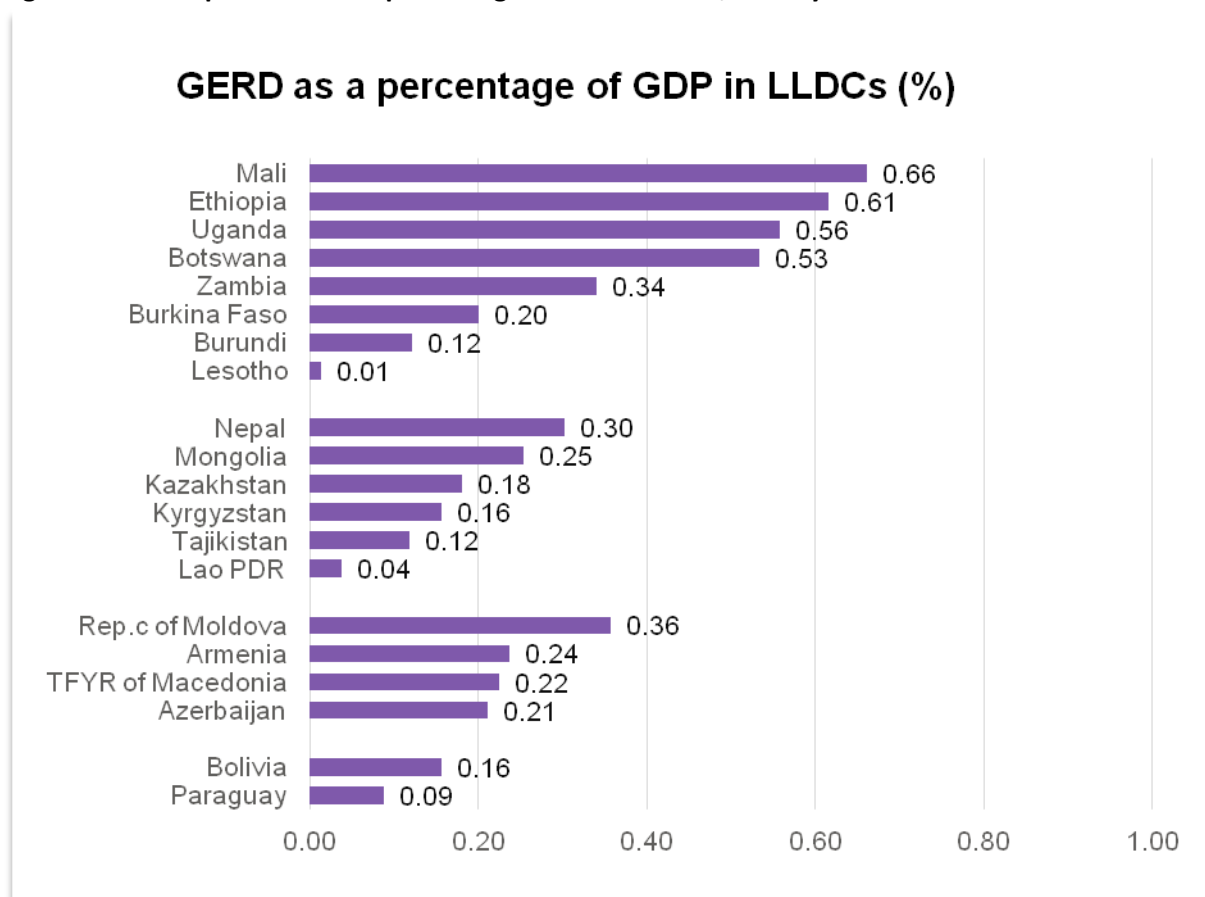
Since its establishment as an institute in 2001, the UIS has completed six rounds of its biennial R&D survey, collecting data on the human resources and expenditure devoted to R&D for the time period 1996 to 2013. Data availability for the LLDCs, SIDS and LDCs is mixed. In addition, there are methodological issues, such as partial coverage, no information on full-time equivalents, incomplete time series, etc.

The most widely used R&D indicator is the amount of R&D expenditure spent, expressed as a percentage of GDP. The global average for this indicator is 1.8%, but this hides a wide variation between developing and developed countries. For the developed countries, the average is 2.3%, while for developing countries (excluding the least developed countries – LDCs) this number drops to 1.1% and for the LDCs, it stands at 0.2% only. Figures 1 to 3 show the situation for the LLDCs, LDCs and SIDS respectively.

Figure 1 shows that in terms of expenditure, all of the LLDCs cluster around the LDC average, or at least are closer to the LDC average than to the developing countries excluding LDCs average. Many developing countries have set a target of reaching at least 1% of GDP devoted to R&D, and it can be observed that the LLDCs are quite far away from this target. Positive exceptions are Mali, Ethiopia,

Uganda and Botswana, which are all substantially above the LDC average, although with still some way to go before hitting the 1% target.

Figure 1: R&D expenditure as a percentage of GDP in LLDCs, latest year available



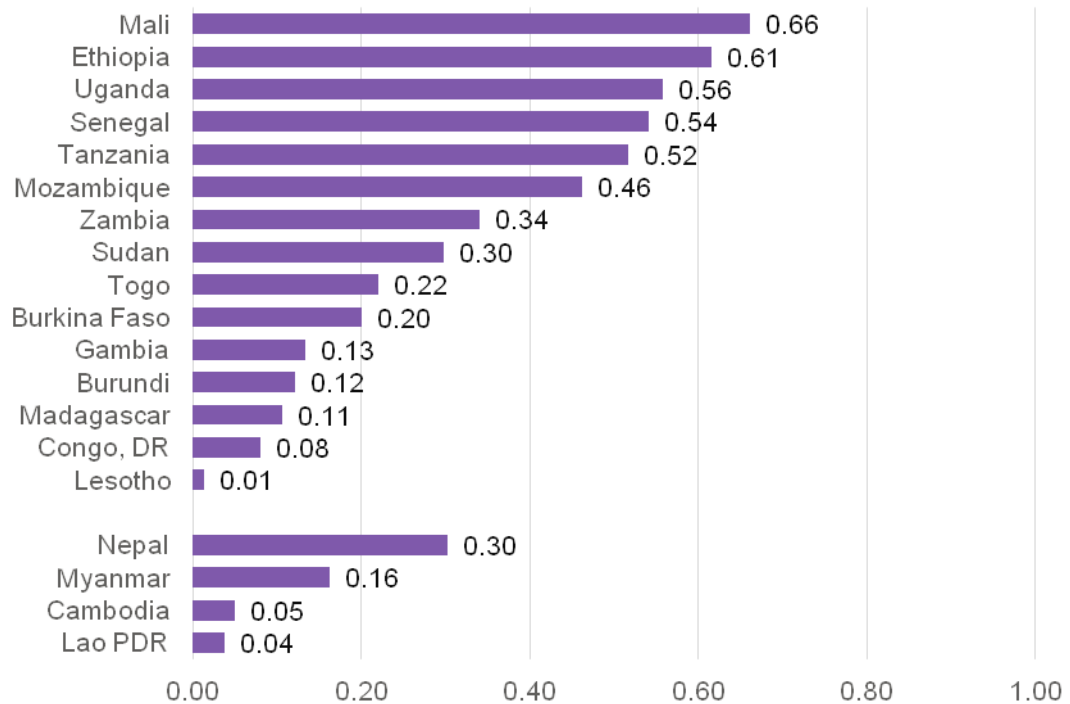
Source: UNESCO Institute for Statistics database, April 2015

Notes: Lesotho: Higher Education only; Armenia, Mali and Tajikistan: excluding Business enterprise sector; Lao PDR: partial data.

Figure 2 shows the same indicator for the LDCs, for which the same analysis applies as for the LLDCs (partly because of the overlap in country composition). Most of the LDCs (logically) cluster around the LDC average of 0.2%, with only five countries above 0.5%, Mali, Ethiopia, Uganda, Senegal and Tanzania.

Figure 2: R&D expenditure as a percentage of GDP in LDCs, latest year available

GERD as a percentage of GDP in LDCs (%)

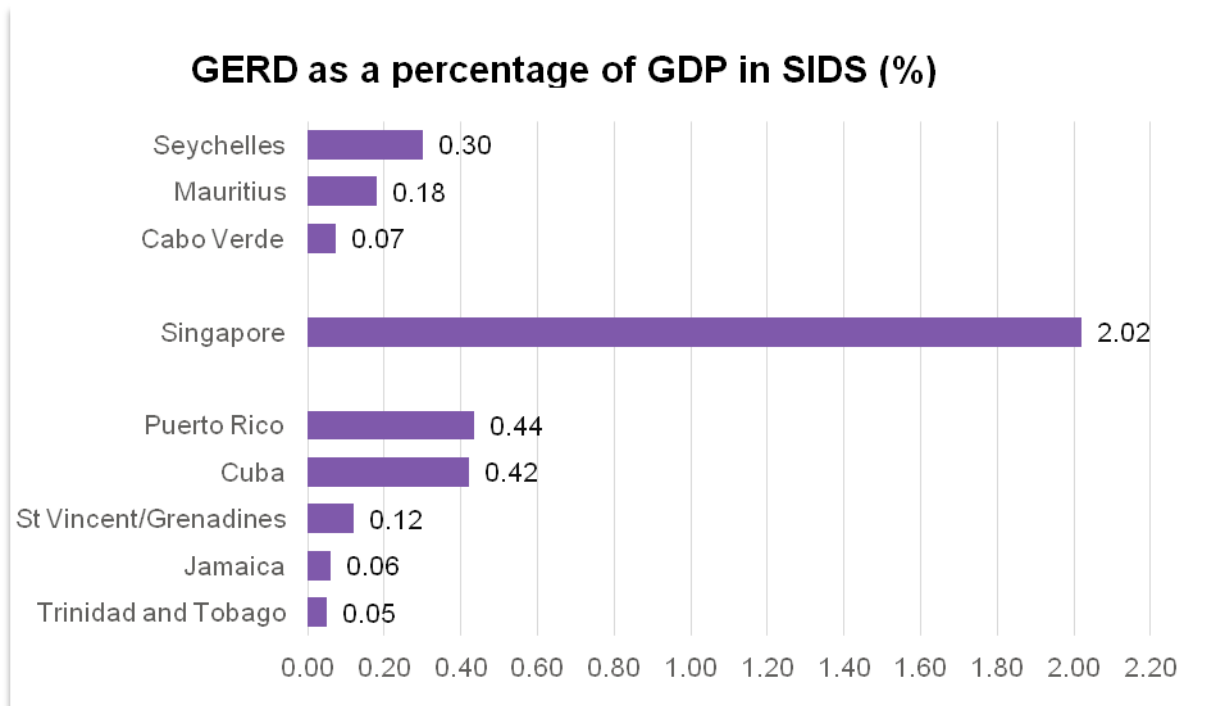


Source: UNESCO Institute for Statistics database, April 2015

Notes: Congo, DR: Government only; Lesotho: Higher Education only; Mali, Mozambique, Tanzania and Togo: excluding Business enterprise sector; Cambodia, Madagascar, Myanmar and Lao PD: partial data; Gambia and Sudan: overestimated or based on overestimated data.

For the few SIDS for which R&D data are available, none spend more than 0.5% of GDP on R&D, with the exception of Singapore, which seems to be a bit out of place in this group (see Figure 3).

Figure 3: R&D expenditure as a percentage of GDP in SIDS, latest year available



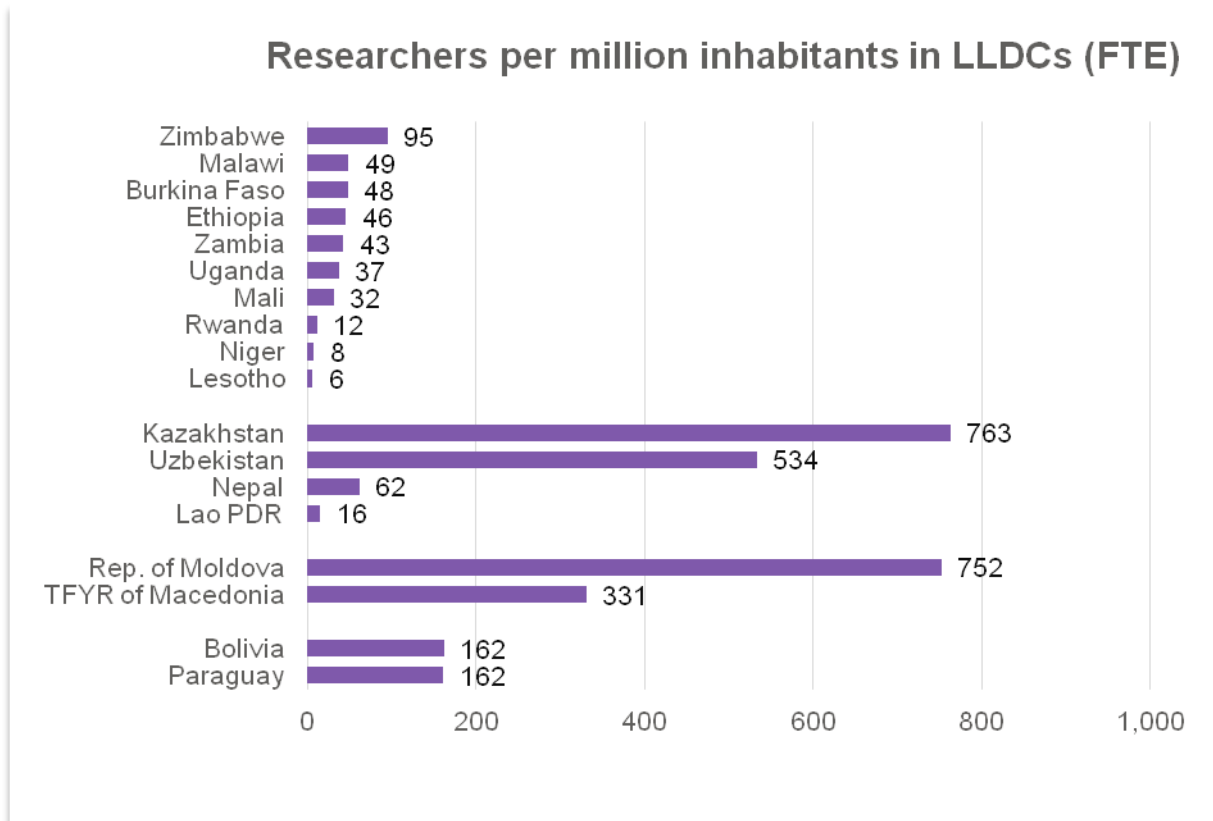
Source: UNESCO Institute for Statistics database, April 2015

Notes: Cabo Verde: Higher Education only; Mauritius: excluding Business enterprise sector.

Shifting the focus from expenditure to personnel, Figures 4 to 6 show the number of researchers is relative to the population of each country. Data are expressed in full-time equivalent, which can be considered as the true volume of the effort devoted to R&D. The global average for this indicator is somewhat more than 1000 researchers per million inhabitants. In developed countries, the number stands at more than 3600, while in developing countries (excluding LDCs), the number stands at just over 500 and in the LDCs, this indicator doesn't reach 50.

Figure 4 shows that many of the LLDCs indeed belong to the LDCs, in particular in Africa. The data for the Asian and European LLDCs hover more around the average for the developing countries excluding the LDCs.

Figure 4: Researchers per million inhabitants (in full-time equivalent) in the LLDCs, latest year available

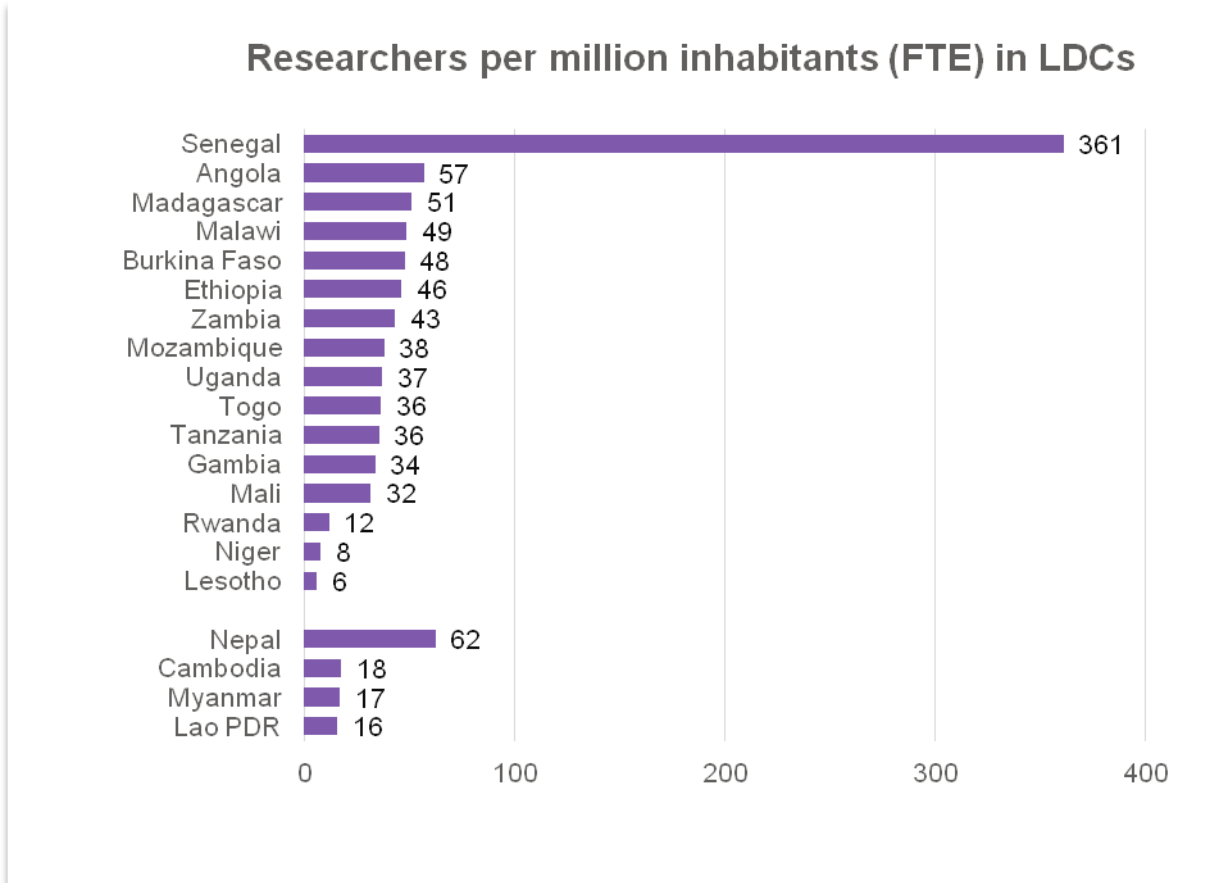


Source: UNESCO Institute for Statistics database, April 2015

Notes: Lesotho and Rwanda: Higher Education only; Malawi and Zimbabwe: excluding Business enterprise sector; Niger and Lao PDR: partial data; Uzbekistan: overestimated or based on overestimated data.

For the LDCs, Senegal is the exception, with a much higher share of FTE researchers per million inhabitants than the other LDCs, as shown in Figure 5.

Figure 5: Researchers per million inhabitants (in full-time equivalent) in the LDCs, latest year available

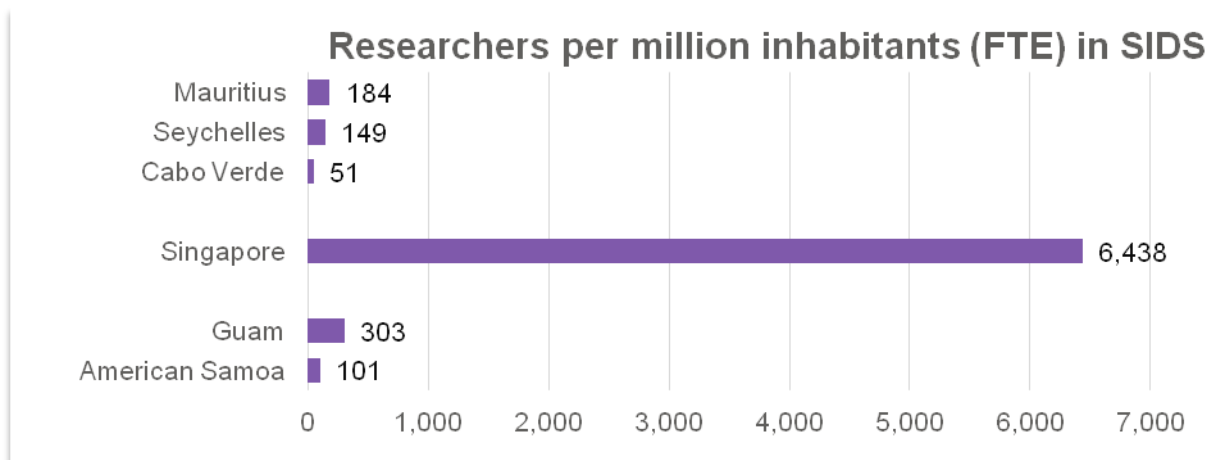


Source: UNESCO Institute for Statistics database, April 2015

Notes: Lesotho and Rwanda: Higher Education only; Malawi, Mozambique, Tanzania and Togo: excluding Business enterprise sector; Cambodia, Gambia, Niger, Madagascar, Myanmar and Lao PD: partial data.

Most of the SIDS (again, for which there are data), apart from highly developed, resource intensive Singapore, are somewhat above the average number of researchers per million inhabitants (see Figure 6).

Figure 6: Researchers per million inhabitants (in full-time equivalent) in the SIDS, latest year available



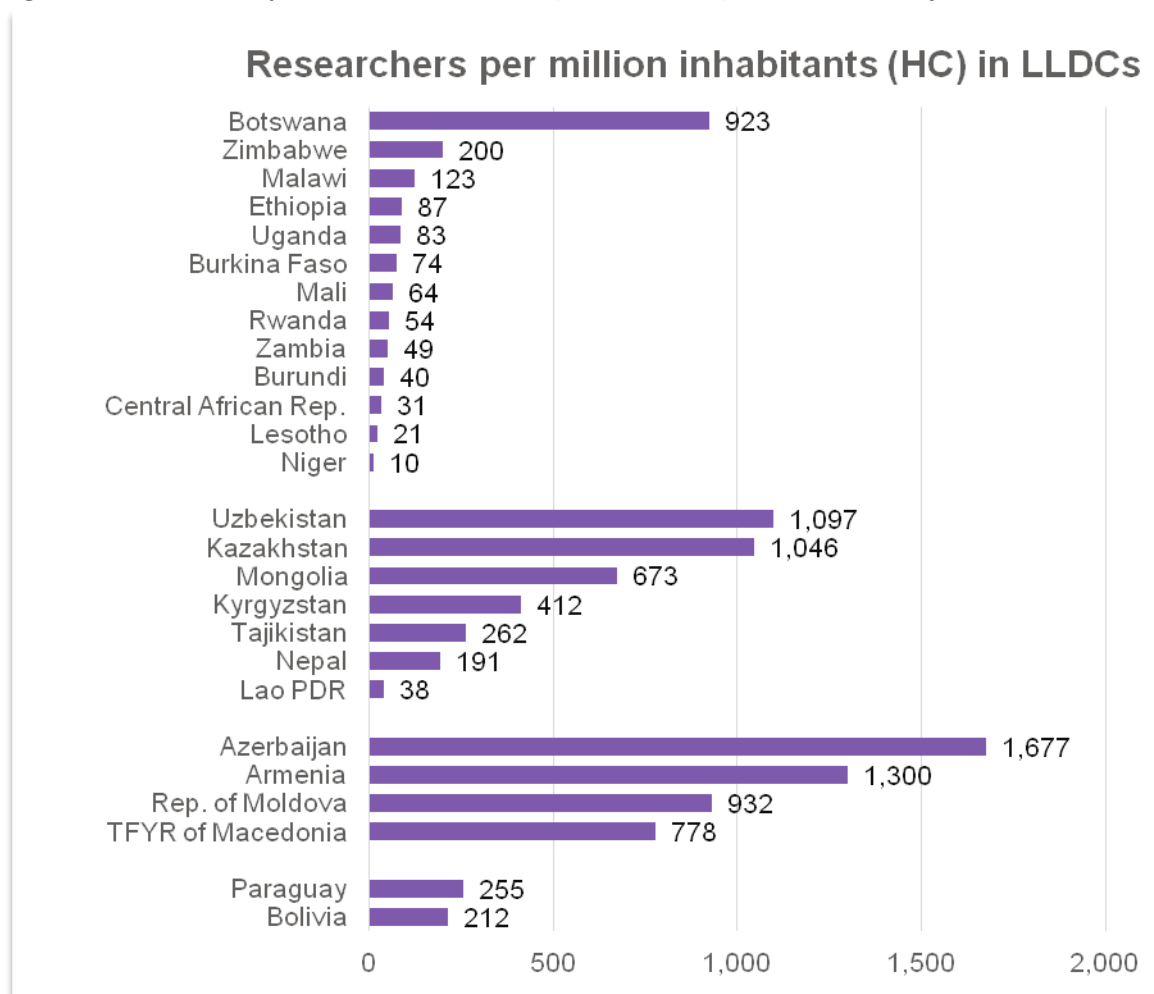
Source: UNESCO Institute for Statistics database, April 2015

Notes: Cabo Verde: Higher Education only; Mauritius: excluding Business enterprise sector; American Samoa and Seychelles: partial data.

Headcount data simply count the number of people active in R&D, without taking into account their time allocated to R&D, as opposed to other tasks (such as teaching, for example, in a university setting). Therefore, headcount data generally overestimate the true amount of research carried out. The advantage of this indicator though is that it is easier to collect, leading to a greater data availability, which can be seen from Figures 7 to 9. These figures present the same indicator as Figures 4 to 6, except that the data are expressed in head counts. The picture remains the same, but more countries are shown.

For the LLDCs, which are shown in Figure 7, notable additions are Armenia and Azerbaijan, which have the highest relative numbers of researchers of the LLDCs.

Figure 7: Researchers per million inhabitants (in headcount) in LLDCs, latest year available

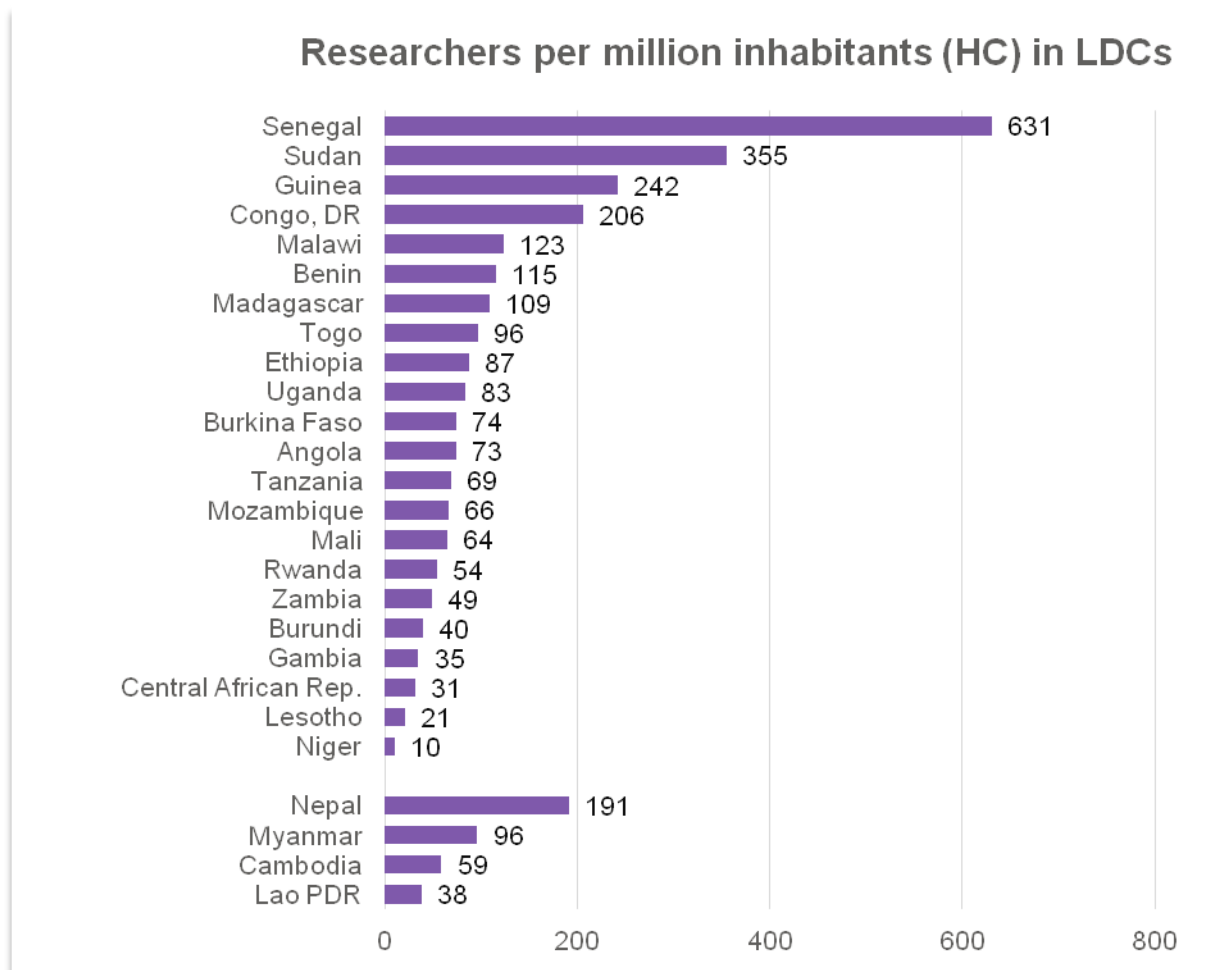


Source: UNESCO Institute for Statistics database, April 2015

Notes: Botswana, Burundi, Central African Rep., Niger and Lao PDR: Partial data; Lesotho and Rwanda: Higher Education only; Armenia, Malawi, Tajikistan and Zimbabwe: excluding Business enterprise sector.

Figure 8 shows the number of researchers in headcount per million inhabitants for the LDCs, where Senegal has the highest share, followed by Sudan and Guinea.

Figure 8: Researchers per million inhabitants (in headcount) in LDCs, latest year available

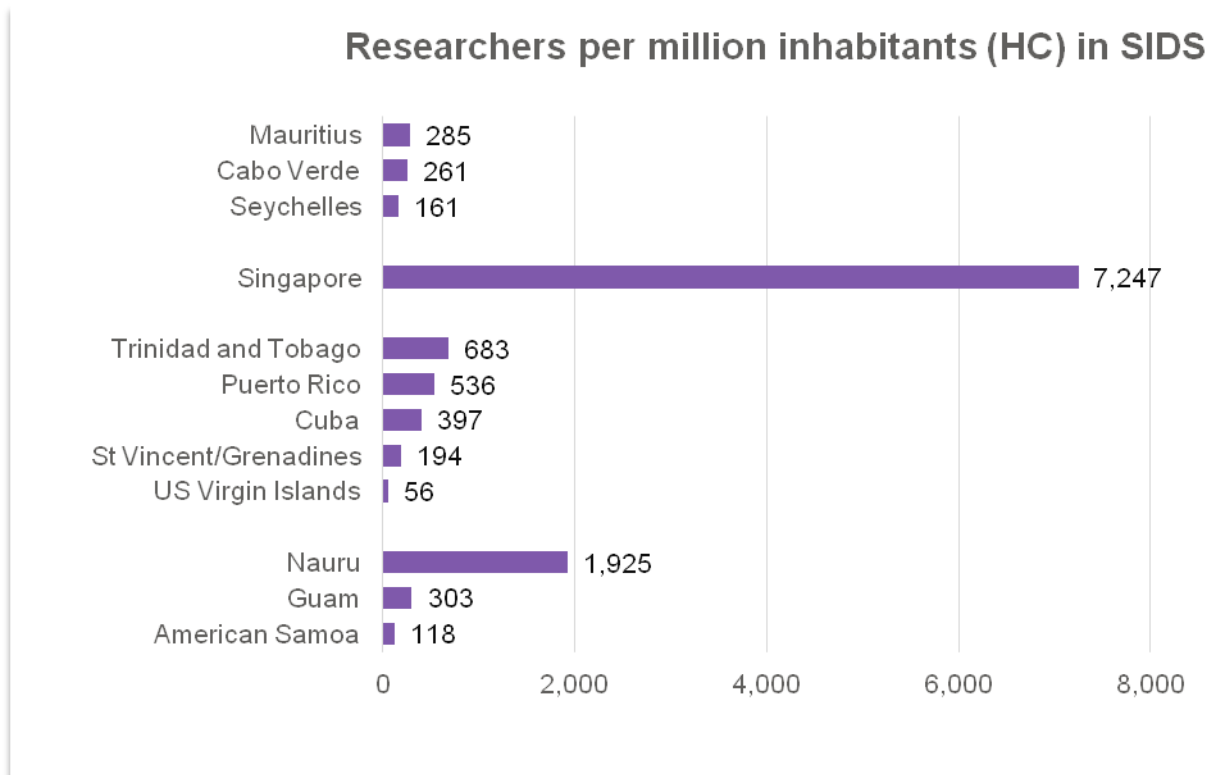


Source: UNESCO Institute for Statistics database, April 2015

Notes: Lesotho and Rwanda: Higher Education only; Malawi, Mozambique, Tanzania and Togo: excluding Business enterprise sector. Benin, Cambodia, Central African Rep., Gambia, Guinea, Niger, Madagascar, Myanmar and Lao PD: partial data; Congo, DR and Sudan: overestimated or based on overestimated data.

In Figure 9, there are some additional data for SIDS as well, compared with FTE data. The data for Nauru are relatively high, although these are very much outdated and need to be corroborated by more recent data.

Figure 9: Researchers per million inhabitants (in headcount) in SIDS, latest year available



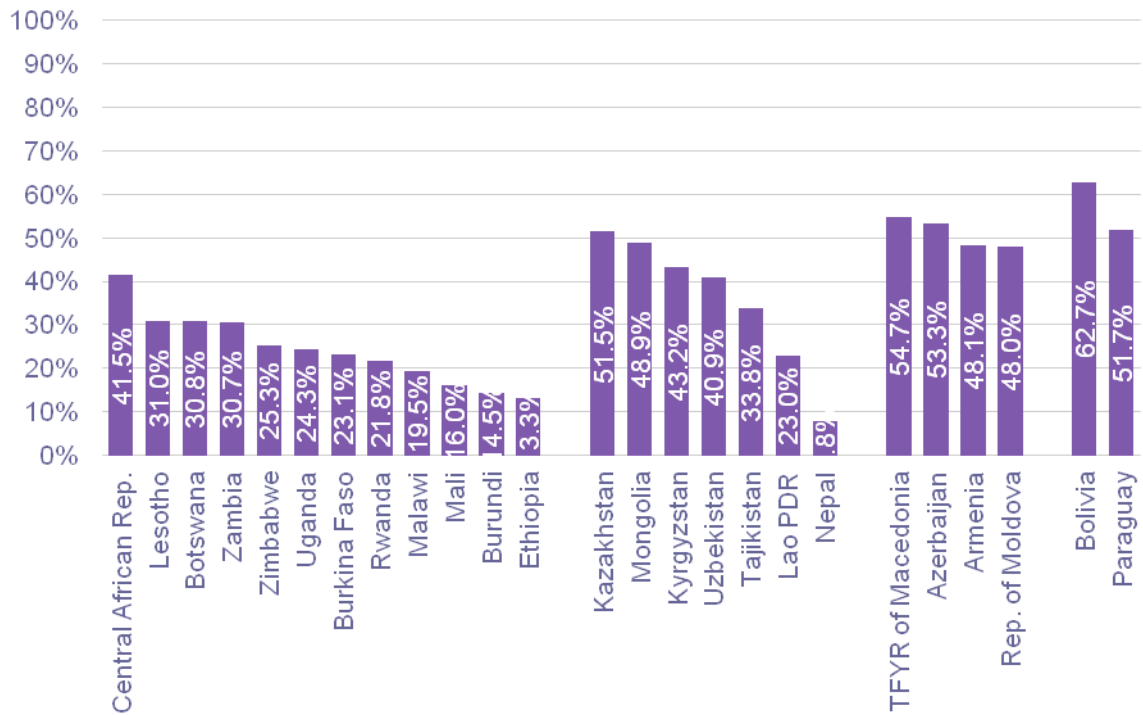
Source: UNESCO Institute for Statistics database, April 2015

Notes: Cabo Verde: Higher Education only; Mauritius: excluding Business enterprise sector; American Samoa, Nauru, Seychelles and US Virgin Islands: partial data.

Globally, around 30% of researchers are female. Figure 10 shows that all African LLDCs around or below this average, while in many of the other LLDCs gender parity (defined as a share of female researchers between 45 and 55%) is reached. In the case of former communist countries and the Latin American countries, this pattern is observed region wide, and is not restricted to the LLDCs.

Figure 10: Female researchers as a % of the total (in headcount) in LLDCs, latest year available

Female researchers as a percentage of total researchers (HC) in LLDCs



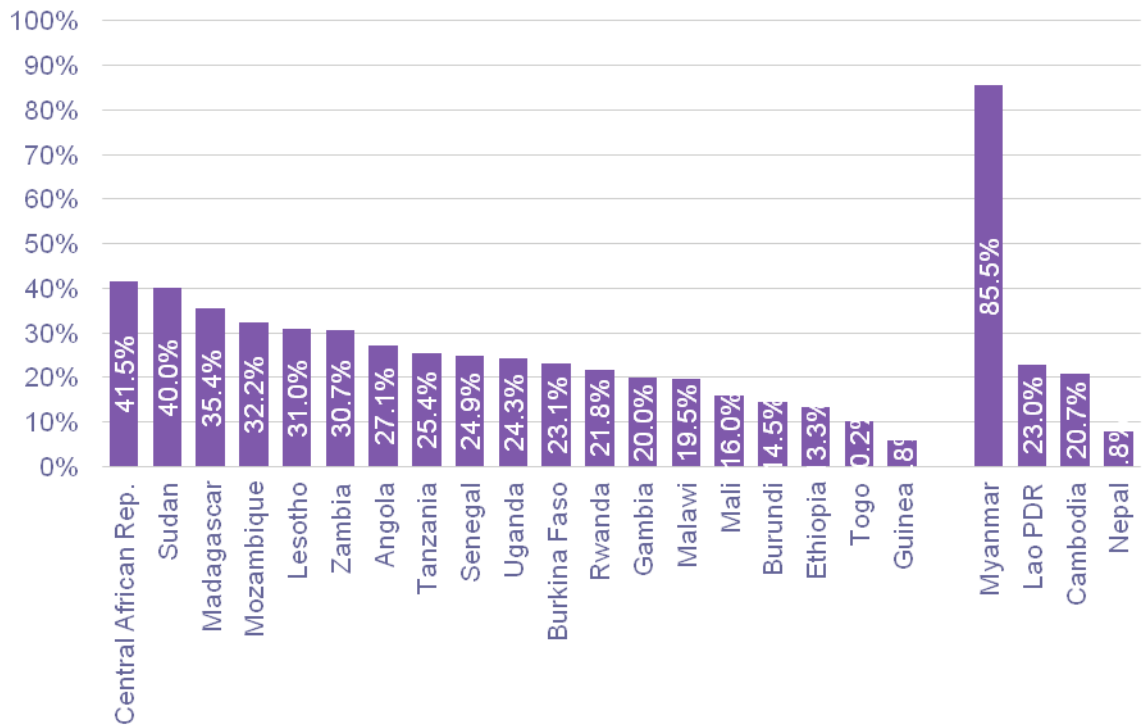
Source: UNESCO Institute for Statistics database, April 2015

Notes: Botswana, Central African Rep., and Lao PDR: Partial data; Lesotho and Rwanda: Higher Education only; Armenia, Malawi, Tajikistan and Zimbabwe: excluding Business enterprise sector.

Figure 11 shows that in none of the LDCs gender parity is reached, with the Central African Republic and Sudan coming closest. The case of Myanmar is based on data from a long time ago, 2002, which is the only year for which the country ever reported R&D data to the UIS.

Figure 11: Female researchers as a % of the total (in headcount) in LDCs, latest year available

Female researchers as a percentage of total researchers (HC) in LDCs



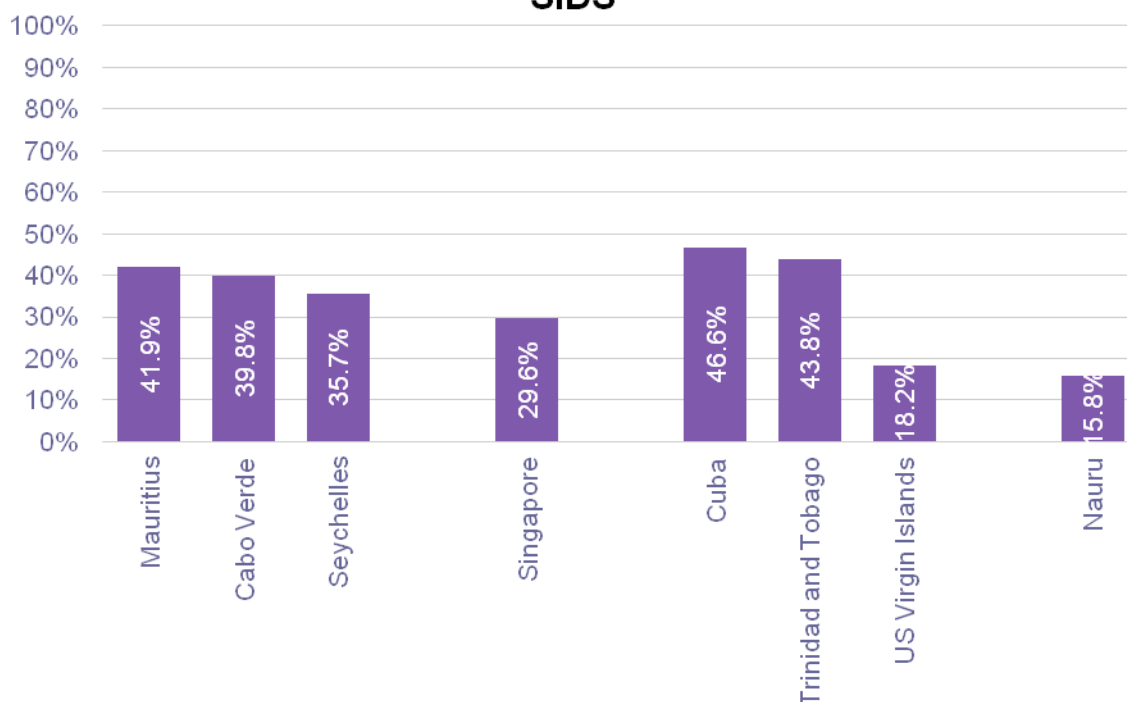
Source: UNESCO Institute for Statistics database, April 2015

Notes: Lesotho and Rwanda: Higher Education only; Malawi, Mozambique, Tanzania and Togo: excluding Business enterprise sector; Cambodia, Central African Rep., Gambia, Guinea, Madagascar and Lao PD: partial data; Myanmar and Sudan: overestimated or based on overestimated data.

For the SIDS, gender parity is reached in Cuba, with Trinidad and Tobago and Mauritius not far away (see Figure 12).

Figure 12: Female researchers as a % of the total (in headcount) in SIDS, latest year available

Female researchers as a percentage of total researchers (HC) in SIDS



Source: UNESCO Institute for Statistics database, April 2015

Notes: Cabo Verde: Higher Education only; Mauritius: excluding Business enterprise sector; Nauru, Seychelles and US Virgin Islands: partial data.

Innovation

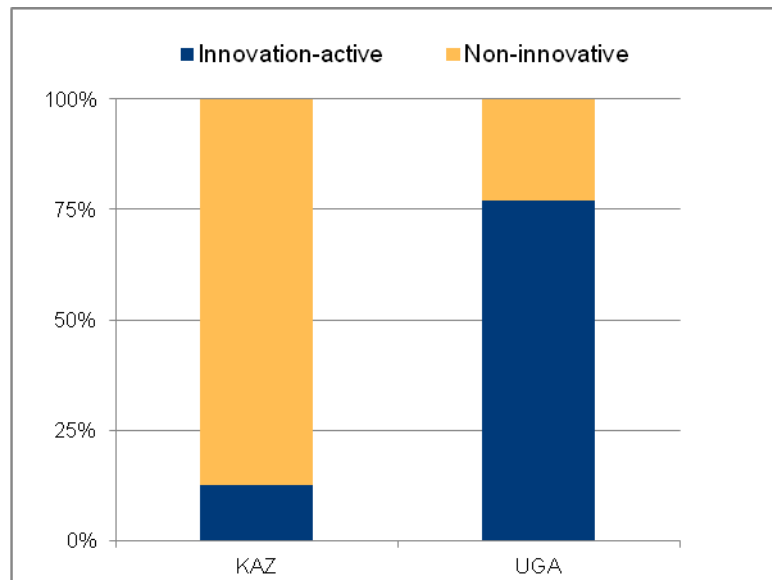
R&D, although important, is only part of innovation activities; innovation is a much broader concept. Innovation is how firms bring new products to market, or how they improve their internal processes to bring products in a more efficient or effective way to market. Diffusion is a key word. Priority 4 of A/CONF.225/PC/L.4 highlights the importance of innovation, by saying that “(s)tructural transformation requires the process of creating new areas of activities and the shifting of resources from lower value-added and low productivity activities to higher value-added and high productivity activities. (...) This includes a targeted action for LLDCs to encourage innovation and industrial entrepreneurship and enterprise formation, including for small and medium-sized enterprises, and promote foreign direct investment with strong backward and forward linkages as well as value retention.”

The UIS has recently conducted its first global data collection of innovation statistics, to which two of the LLDCs have responded, Kazakhstan and Uganda. Brief results for these countries are presented in the following Figures, followed by the information for the LDCs that provided information, Uganda and Tanzania, and the only SIDS that provided information, Cuba.

Innovation-active firms are those firms that either implemented an innovation or had abandoned or ongoing innovation activities for innovation, where we focus only on product and process innovation (and ignore marketing and organisational innovation, which is usually part of an innovation survey as

well). Figure 13 shows the results for Kazakhstan and Uganda. The figure shows a low share of firms that implemented or were developing product or process innovations in Kazakhstan, while the share in Uganda is remarkably high. Uganda's share of innovation-active firms is heavily composed by firms that in fact implemented product or process innovations, with a relatively lower participation of firms that only had abandoned or ongoing innovation activities.

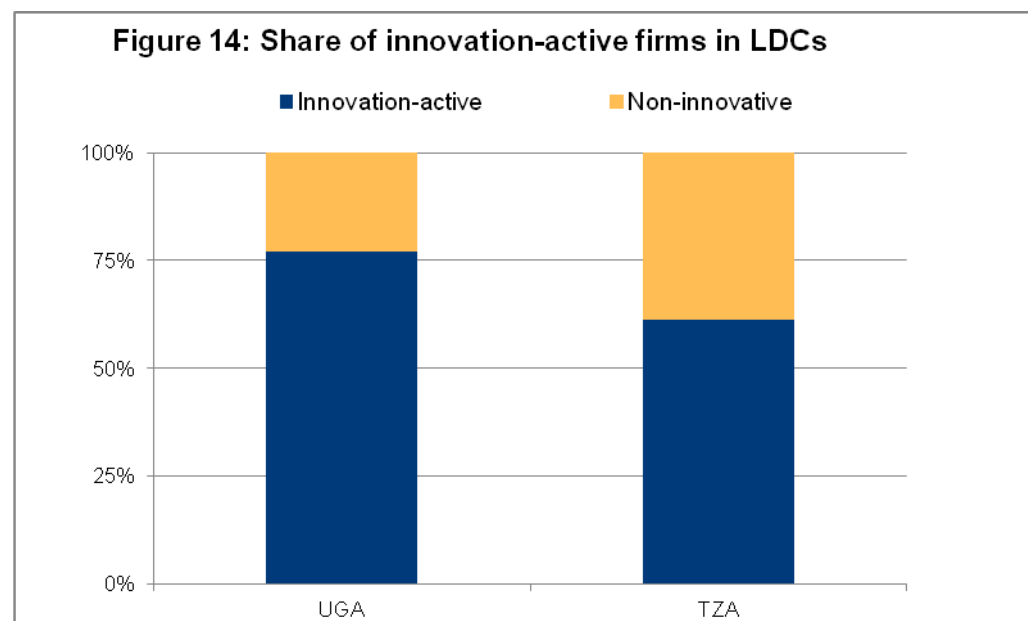
Figure 13: Share of innovation active firms in LLDCs



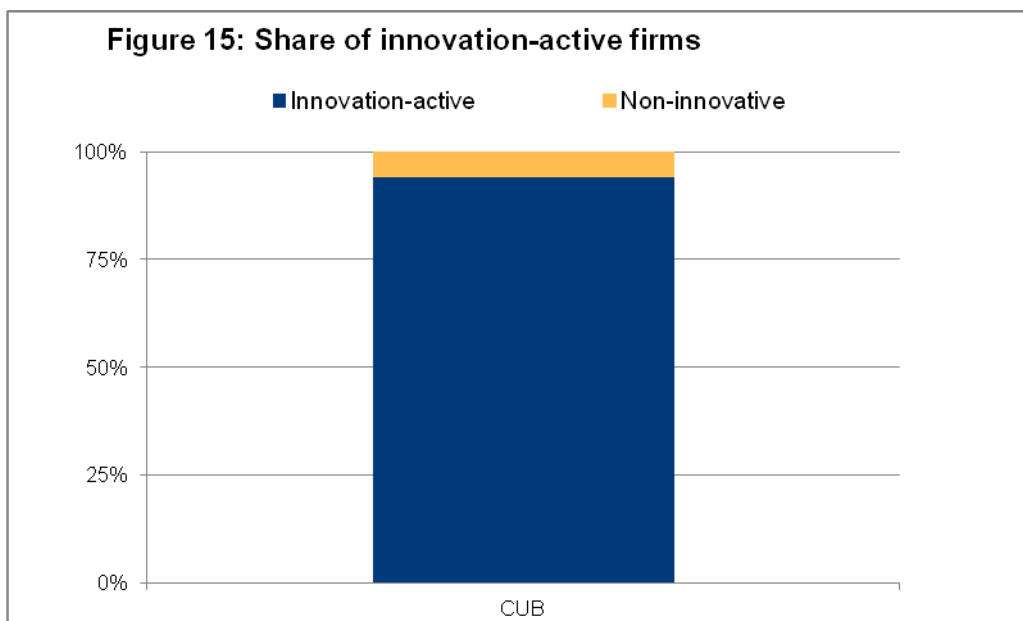
Source: UNESCO Institute for Statistics database, October 2014

Notes: Data for Kazakhstan cover manufacturing only and data for Uganda cover mining, manufacturing and services.

Figures 14 and 15 show the same information for the LDCs and the SIDS.



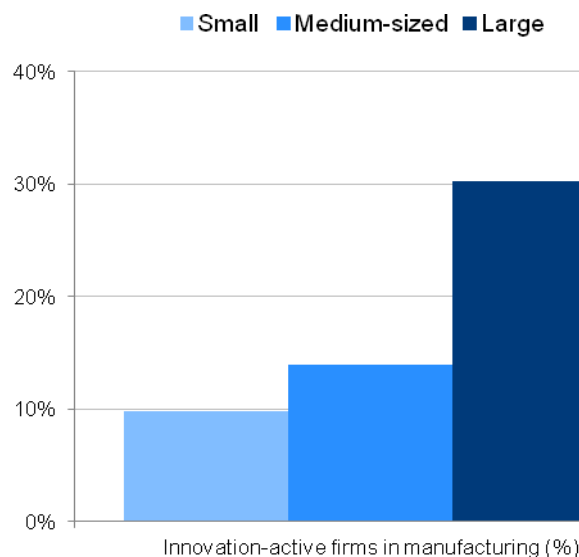
Source: UNESCO Institute for Statistics database, October 2014



Source: UNESCO Institute for Statistics database, October 2014

Size matters when it comes to innovation: the larger the firm-size, the higher the share of innovators. This is not different in Kazakhstan, particularly in product or process innovation-active firms (see Figure 16).

Figure 16: Share of innovation-active firms by size class, Kazakhstan



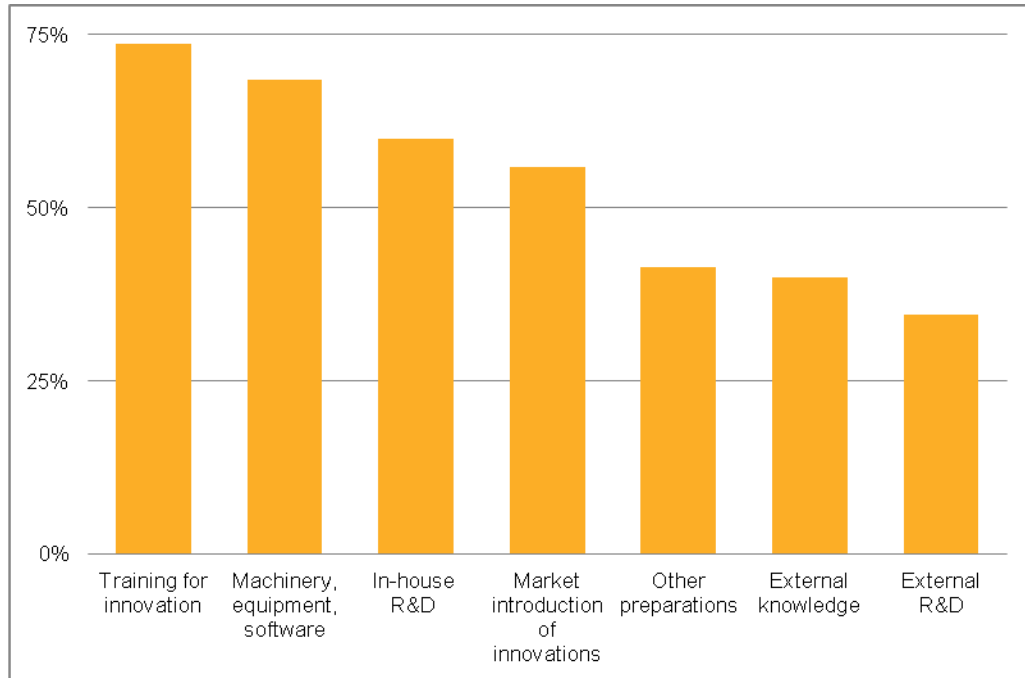
Source: UNESCO Institute for Statistics database, October 2014

This information is not available for the LDCs and the SIDS.

Figure 17 highlights that innovation goes beyond R&D. Although there is a relatively large share of firms engaging in in-house R&D in Uganda, when compared with other countries in the UNESCO Institute for Statistics database, there are still many firms that innovated without carrying out R&D activities, which goes to prove that innovation is a broader concept. The most important categories

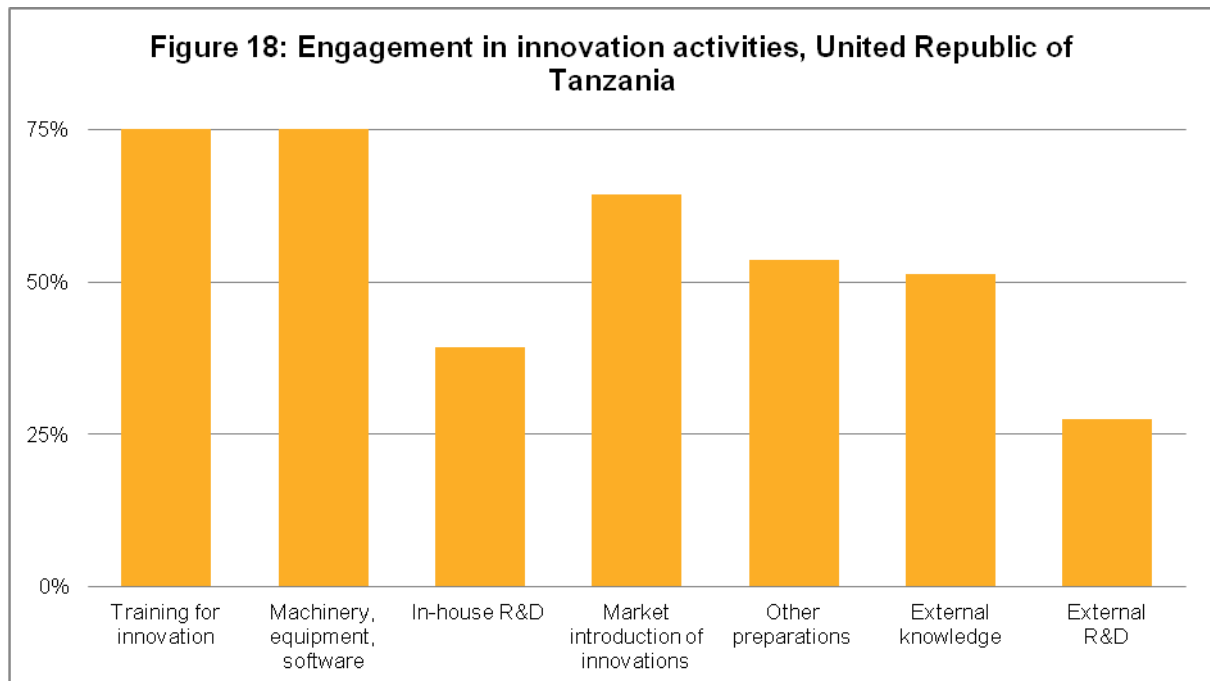
are training and the acquisition of machinery, equipment and software, which is a result we find in many countries.

Figure 17: Engagement in innovation activities of mining, manufacturing and services firms in Uganda

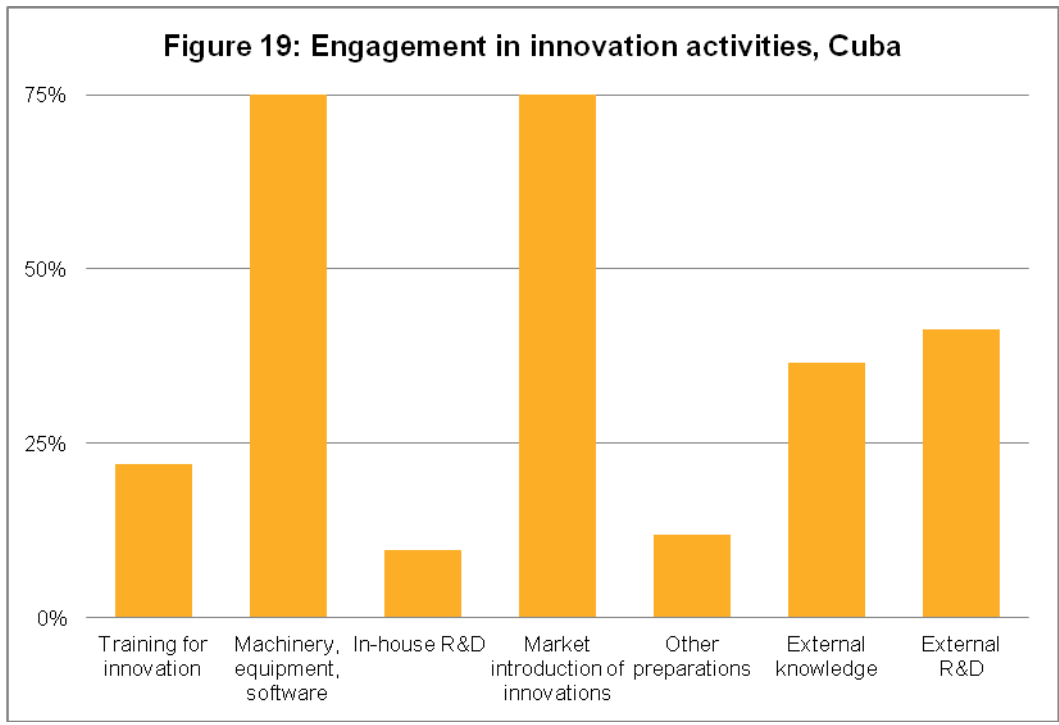


Source: UNESCO Institute for Statistics database, October 2014

Figure 18 shows the same information for Tanzania, and Figure 19 for Cuba, confirming that innovation happens without R&D.



Source: UNESCO Institute for Statistics database, October 2014



Source: UNESCO Institute for Statistics database, October 2014