

Africa's vaccines manufacturing revolution: Lessons from COVID-19, ongoing efforts, and challenges to overcome

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Abstract

The COVID-19 pandemic exposed significant disparities in global vaccine production and distribution, with Africa being disproportionately impacted. Despite accounting for 17% of the global population, the continent received only a small fraction of the initial global vaccine supply. Currently, 99% of vaccines used in Africa are imported, with only 1% produced locally. The pandemic underscored the critical need for Africa to achieve self-sufficiency in vaccine production, highlighting the importance of developing manufacturing capacity for future pandemic preparedness and the eradication of infectious diseases. In response, Africa has set a target to locally produce 60% of its vaccine requirements by 2040, supported by initiatives such as the Partnerships for African Vaccine Manufacturing (PAVM), the African Vaccine Manufacturing Accelerator (AVMA), and the Regionalized Vaccine Manufacturing Collaborative (RVMC), along with other considerable efforts. Despite progress, challenges related to infrastructure, human resources, and financing remain. This paper aims to describe Africa's vaccine manufacturing revolution, drawing lessons from COVID-19, exploring ongoing efforts, and addressing the challenges that must be overcome to achieve vaccine independence in the near future.

Keywords: vaccinology, vaccine production, capacity building, Africa

Introduction

The COVID-19 pandemic revealed profound disparities in global vaccine production and distribution, with Africa being disproportionately affected.¹ Despite having a population exceeding 1.4 billion, which accounts for approximately 17% of the world's population, the continent received a minimal share of the global vaccine supply during the initial rollout.²

As of February 2022, only 11% of Africa's population had been fully vaccinated against COVID-19, in stark contrast to vaccination rates exceeding 70% in several high-income and upper-middle-income countries.³ In October 2021, the WHO published an ambitious strategy to ensure that all countries had vaccinated 40% of their population by the end of 2021 and 70% by mid-2022. As of June 26, 2022, only two countries in the WHO African region had achieved this target (Mauritius and Seychelles).⁴ African countries lagged 3–6 months behind in their vaccination campaigns when compared with countries with stronger manufacturing, resulting in lower coverage and increased vulnerability. From January 1, 2020, to December 31, 2021, Africa had more than 439,500 deaths from COVID-19, a number worsened by limited vaccine access.^{5,6} These disparities in vaccine access still exist in 2025, with 51.8% of the population fully vaccinated for COVID-19 in Africa,⁷ compared to 70.6% global coverage.⁸

The COVID-19 pandemic underscored the significant reliance of African countries on imported vaccines, with 99% of the vaccines used across the continent being sourced externally, and only 1% produced locally.⁹ And this reliance extends beyond vaccines: Africa imports about 80–90% of medicines and 98% of medical devices, disposables, and equipment. Overall, over 95% of medical products — including vaccines, pharmaceuticals, and devices — used in Africa are sourced externally.¹⁰

In Africa, vaccine manufacturing capacity exists in a limited number of countries, including Egypt, Morocco, Senegal, Tunisia, and South Africa, with the largest production facility being the Biovac Institute in Cape Town, South Africa. Most of these manufacturing plants, however, are predominantly involved in downstream processes, such as vial filling and packaging, rather than in complete end-to-end vaccine production from raw materials to finished products.¹¹

The COVID-19 pandemic highlighted Africa's urgent need for self-sufficiency in vaccine production, emphasizing the importance of enhancing manufacturing capacity for future pandemic preparedness and the eradication of infectious diseases through vaccination.¹² As of July 2022, Africa had received only 7.8% of the 9 billion COVID-19 vaccine doses produced globally.¹³ Notably, such disparities predated the pandemic, with 9.4 million African children annually missing the final DTP vaccine dose.¹⁴

Working with international organizations and private sector partners, many African nations have initiated a strategic transformation of the continent's vaccine manufacturing

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sector. Vaccine production in Africa has grown through increased collaboration among industry, academia, governments, and non-profits to boost R&D, manufacturing, and equitable access.¹⁵ In 2021, the African Union Heads of State and Governments established the Partnerships for African Vaccine Manufacturing (PAVM) under the Africa CDC. PAVM aims to enable Africa to produce and supply over 60% of the vaccines required on the continent by 2040; interim goals include reaching 10% by 2025 and 30% by 2030.¹⁶ This collaboration has led to the development of several vaccine manufacturing initiatives, aiming to ensure Africa's self-reliance in the event of future health emergencies or disease outbreaks.

Along with decreasing dependency on vaccine imports during health crises, expanding vaccine manufacturing capabilities across Africa also has significant potential to establish regional supply chains for a broad spectrum of essential vaccines targeting various infectious diseases.¹⁷ Africa's vaccine production capacity must not be limited to pandemic scenarios like COVID-19. Numerous infectious diseases, prevalent in Africa and other regions, currently lack adequate vaccine production or require the development of new ones. These include HIV, dengue fever, Chikungunya, Rift Valley Fever, Zika, Nipah, Lassa fever, Marburg, non-Zaire strains of Ebola, pandemic influenza, adult tuberculosis, and respiratory syncytial virus (RSV). Many of these diseases have been identified by the World Health Organization (WHO) as having pandemic potential.¹² In response, the Coalition for Epidemic Preparedness Innovations (CEPI) is already supporting the development of vaccines for those diseases, reinforcing the need for Africa to bolster its manufacturing capabilities for a wide range of public health threats.¹⁸

Achievements and ongoing efforts in expanding Africa's vaccines manufacturing capacity

Existing local vaccines production capacity

In the journey towards achieving 60% local vaccine production by 2040, Africa is not starting from ground zero. Although current production level remains very low relative to demand, a few African countries are already producing vaccines (Table 1). The majority of local capacity, however, is concentrated in Fill & Finish (F&F) processes or importing for distribution, without encompassing the entire production cycle.⁹ This indicates a substantial gap that must be bridged. Increased efforts are needed to expand the production capabilities of existing manufacturers while also encouraging new initiatives aimed at enhancing local vaccine production. Boosting research and development (R&D) and investing in infrastructure will be essential steps in closing this gap and moving toward 60% self-sufficiency in vaccine manufacturing across the continent by 2040.¹⁹

Table 1. Existing capacities in vaccine manufacturing in Africa

Manufacturer	Country	Vaccines*	Production Capacity
Afrigen	South Africa	COVID-19, Hepatitis B, Lift Valley Fever, TB	R&D, DS, F&F
Aspen	South Africa	COVID-19	F&F
Biovac	South Africa	BCG, COVID-19, GBS, Hepatitis B, OCV, OPV, Pneumococcus, Measles	R&D, F&F, Import for distribution
EPI	Ethiopia	Rabies	DS, F&F
Innovative Biotech	Nigeria	COVID-19, Ebola, HIV, HPV, Yellow Fever	R&D
Institut Pasteur d'Algérie	Algeria	Rabies	DS, F&F
Institut Pasteur de Dakar	Senegal	Yellow Fever	DS, F&F
Institut Pasteur Morocco	Morocco	BCG, Influenza, Rabies, Tetanus, Typhoid, Yellow Fever	Import for distribution
Institut Pasteur Tunis	Tunisia	BCG	DS, F&F
Saidal	Algeria	COVID-19	F&F
Vacsera	Egypt	BCG, Cholera, COVID-19, DT, DTP, Hib, Hepatitis A/B/A+B, HPV, Influenza, IPV, Meningitis, MMR, OPV, Pentavalent, Pneumococcal, Rabies, Rotavirus, Tetanus, Typhoid, Varicella, Yellow Fever	F&F, Import for distribution

*Not necessarily covering the complete circle of production: some for R&D, DS, F&F, or imported for distribution; based in 2022 operations.

Source: 2023 Wellcome report: "Scaling Up African Vaccine Manufacturing Capacity"²⁰

Novel initiatives to boost local vaccine manufacturing capacity in Africa

Significant efforts have already begun to achieve the goal of increasing Africa's vaccine manufacturing capacity to 60% by 2040. Local capacity is being developed through nurturing

homegrown talents and fostering international cooperation to build the necessary infrastructure, secure raw materials, and strengthen human resources.²¹ PAVM is a key initiative in this work, and is expected to play a pivotal role in expanding Africa's local vaccine production capabilities.²²

PAVM advocates for the following:

- The establishment of an African vaccine procurement pooling mechanism to provide stability and assurance for local manufacturers.
- The need to strengthen National Regulatory Authorities and Regional Centres of Regulatory Excellence to enhance regulatory standards for vaccines.
- The creation of a Vaccine Manufacturing Deal Preparation Facility to assist manufacturers in developing robust business plans for investors and facilitating project financing for critical vaccine ecosystem enablers.²³
- A Vaccine Technology Transfer & Intellectual Property Brokering Service to connect technology providers with recipients, fostering efficient technology transfer.

Vaccine research and development centres, a coordinating unit for R&D, Regional Capability and Capacity Centres to enhance human capital, and trade policies, all underpinned by a continental strategy with oversight mechanisms.²⁴⁻²⁶

In addition to local efforts and innovative initiatives, Africa has recently witnessed increased international and public-private sector collaboration aimed at enhancing its vaccine production capacity. In December 2023, for instance, GAVI's Board approved the establishment of the African Vaccine Manufacturing Accelerator (AVMA), a financial instrument designed to provide up to US\$1 billion over the next decade to support the sustainable growth of Africa's vaccine manufacturing sector.²⁷ This initiative holds the potential not only to strengthen the global vaccine market but to contribute significantly to outbreak and pandemic prevention, preparedness, and resilience. The AVMA seeks to foster long-term vaccine manufacturing capacity across the continent, ensuring a more robust and responsive public health infrastructure in Africa.²⁷

Another key significant achievement is the establishment of the Regionalized Vaccine Manufacturing Collaborative (RVMC) by the World Economic Forum (WEF) in partnership with Deloitte, the U.S. National Academy of Medicine, and the Coalition for Epidemic Preparedness Innovations (CEPI).^{28,29} This initiative aims to address global inequities in vaccine production, particularly in lower- and middle-income countries. RVMC was created to enhance existing global-scale vaccine production by developing robust regional

manufacturing facilities capable of operating during both pandemics and routine health periods, and tailored to the specific health needs of each region.²⁸ The initiative will commence with an initial \$15 million commitment from CEPI. RVMC will provide essential services such as convening, advocacy, matchmaking, technical support, and thought leadership to support and accelerate the success of regional vaccine manufacturing initiatives worldwide.²⁹

As an example of collaboration in vaccine initiatives, the Saving Lives and Livelihoods Initiative serves as a leading example of partnership-driven impact in Africa. Launched in June 2021 as a \$1.5 billion collaboration between the Mastercard Foundation and Africa CDC, the initiative was established to rapidly scale up COVID-19 vaccination efforts across the continent, while also strengthening the public health workforce and expanding local vaccine manufacturing and pandemic preparedness.³⁰ By 2024, the initiative had delivered over 34 million vaccine doses in 25 countries, upgraded cold-chain systems in 32 member states, expanded the number of genomic sequencing labs from 2 to 32, generated over 22,000 jobs, and trained 38,000 health workers.³¹ With the end of COVID-19 as a public health emergency, the initiative transitioned into a second phase (August 2024–December 2025) with a \$638 million budget, focusing on integrating COVID-19 vaccines into routine immunization, protecting vulnerable populations, expanding the health workforce, and strengthening Africa's public health institutions and pandemic preparedness.³⁰⁻³²

In addition to these efforts, major international vaccine manufacturers are establishing production plants in Africa to help increase the continent's local vaccine production capacity. In June 2022, for example, BioNTech began construction of a state-of-the-art manufacturing facility in Kigali, Rwanda, for the production of mRNA-based therapeutics and vaccine candidates.³³ This facility is expected to serve as the first node in a broader, decentralized end-to-end manufacturing network across Africa. Initially, it will house two sets of BioNTainers designed for the synthesis of bulk mRNA vaccines. In March 2023, the first of six ISO-sized containers were delivered to Kigali.³⁴ BioNTech staff will oversee operations and, after training local personnel, transfer expertise and ownership to local entities. Vaccines produced at this facility will be provided to other African Union member states at a not-for-profit price. BioNTech is also planning to build additional facilities in Senegal and South Africa.³⁵ Table 2 summarizes the discussed regional vaccine manufacturing initiatives and their current progress in supporting the vaccine manufacturing industry in Africa.

Since their establishment, these different initiatives—aimed at strengthening Africa's vaccine industry—have driven major progress in manufacturing capacity, financing, workforce development, and regulatory systems. Africa has shifted from

producing less than 1% of its vaccines locally to setting a clear goal of achieving 60% local production by 2040.³⁶ This progress is supported by initiatives such as the Partnerships for African Vaccine Manufacturing (PAVM) and the African Vaccine Manufacturing Accelerator (AVMA).^{37,38} Currently, the continent hosts over 25 vaccine manufacturers, with 10 having installed production capacity, and three advancing toward WHO prequalification for eight vaccines by 2030.³⁹ Regional Capability and Capacity Networks have been launched to address workforce gaps, while technology transfers—particularly in mRNA development—are driving innovation.²³ Although challenges remain, these coordinated efforts are enhancing pandemic preparedness, reducing import dependence, and improving vaccine access, laying the foundation for a resilient and self-reliant vaccine manufacturing ecosystem in Africa.

Challenges to overcome and recommendations to consider

Despite promising efforts, scaling up Africa's vaccine production faces significant challenges. Key issues include the technical expertise gap in advanced vaccine production processes, a "brain drain" among vaccine professionals, infrastructure limitations, and insufficient funding and investment.¹⁴ Additionally, African manufacturers rely heavily on imported raw materials, making them vulnerable to global supply chain disruptions and expensive products.^{14,40} The fragmented market and demand uncertainty further complicate sustainable operations, while weak regulatory frameworks hinder quality control and standardization across the continent.¹⁰ Addressing these challenges requires coordinated efforts by African governments and stakeholders to develop a robust ecosystem that supports local vaccine production and helps realize Africa's 2040 vision for health security.

Human resources and technical expertise are critical drivers of industrial growth, particularly in the vaccine production sector.⁴¹ Africa continues, however, to face substantial challenges in addressing gaps in technical know-how and the persistent brain drain among scientists and vaccine experts.⁴² The shortage of professionals with the specialized skills required to develop and produce advanced vaccines has resulted in an over-reliance on external support. The migration of highly trained individuals seeking better career prospects abroad further exacerbates the problem, undermining local scientific capacity and hindering essential knowledge transfer for sustainable vaccine production.⁴³ African nations must prioritize investments in nurturing local talent, strengthen local research institutions, create competitive professional opportunities, and strengthen collaboration across academic, governmental, and industrial sectors for retaining skilled professionals and ensuring the continent's long-term health security.⁴⁴

Limited infrastructure and investment present significant obstacles to vaccine research and development across Africa.² Producing even basic vaccines demands substantial financial investment, with costs reaching up to US\$500 million, while more complex vaccines can require upwards of a billion dollars.⁴⁵ Such investment levels are typically beyond the reach of most health systems in the region, which are already overburdened by various healthcare priorities. In addition, the infrastructure required for vaccine production is highly specialized, including advanced biotechnological tools, sterile environments, and cold chain systems to maintain vaccine quality and efficacy.⁴⁶ Many African nations lack the necessary facilities for large-scale vaccine production, storage, and distribution, and these limitations are further exacerbated by inadequate power supplies, poor transportation networks, and insufficient laboratory capacity.¹⁹ Significant efforts and collaboration are required to establish the infrastructure and secure the funding necessary for sustainable vaccine production on the continent.

Once local talents are nurtured and retained, infrastructure established, and funding allocated, Africa may begin producing significant volumes of vaccines. Market competition must, however, be considered beforehand. African vaccine manufacturers will face strong competition from established global companies, such as the Serum Institute of India, which produces the highest number of vaccine doses worldwide.⁴⁷ The lack of raw materials for vaccine production in Africa, necessitating the importation of essential components, along with other challenges, will likely result in higher production costs for locally manufactured vaccines. In 2023, for instance, the South African government opted to purchase a pneumococcal vaccine from India, as it was less expensive than the domestically produced alternative.⁴⁸ If this trend persists, newly established vaccine production facilities in Africa could face the risk of closure. Addressing all contributing factors, including raw material shortages, is critical to ensure that locally produced vaccines remain competitively priced.

Regulatory and standardization frameworks in African countries continue to face challenges, particularly in vaccine manufacturing.⁴⁹ While National Regulatory Agencies (NRAs) play a critical role in ensuring the safety, efficacy, and quality of therapeutic products, according to the WHO, only 30% of its member states' NRAs are capable of effectively regulating therapeutic goods.⁵⁰ Expanding vaccine production in these regions without adequate regulatory oversight could compromise product quality and erode public trust. The establishment of the African Medicines Agency (AMA) in 2021 represents a significant step toward enhancing regulatory oversight for Africa's emerging vaccine manufacturing sector.⁵¹ To ensure that locally produced vaccines meet international quality standards, Africa's regulatory framework must be harmonized and strengthened. This will accelerate

vaccine approval processes and bolster public confidence in the safety of locally manufactured vaccines.⁵⁰

In-depth research is essential in thoroughly understanding the landscape of vaccine production in Africa, including assessing available resources, identifying needs and limitations, examining key challenges, and exploring effective strategies to overcome them, ensuring sustainable and autonomous vaccine development.

Conclusion

The COVID-19 pandemic underscored the critical need for Africa to achieve self-sufficiency in vaccine manufacturing. While significant efforts have been made toward the goal of locally producing 60% of vaccines used on the continent by 2040, with promising outcomes anticipated, challenges related to infrastructure, material supply, human resources, and financial constraints must be addressed proactively to realize this vision. By identifying and overcoming these barriers early, Africa can not only meet its vaccine production targets but also build a more resilient healthcare ecosystem. Through coordinated and sustained efforts, the continent has the potential to surpass expectations and significantly improve the health and well-being of its population.

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References

1. H. T. Rydland, J. Friedman, S. Stringhini, B. G. Link, and T. A. Eikemo, "The radically unequal distribution of Covid-19 vaccinations: A predictable yet avoidable symptom of the fundamental causes of inequality," *Humanit Soc Sci Commun*, vol. 9, no. 1, pp. 1–6, Feb. 2022, doi: 10.1057/s41599-022-01073-z.
2. A. Asundi, C. O'Leary, and N. Bhadelia, "Global COVID-19 vaccine inequity: The scope, the impact, and the challenges," *Cell Host Microbe*, vol. 29, no. 7, pp. 1036–1039, Jul. 2021, doi: 10.1016/j.chom.2021.06.007.
3. A. WHO, "Africa needs to ramp up COVID-19 vaccination six-fold." Accessed: Apr. 24, 2025. [Online]. Available: <https://www.afro.who.int/news/africa-needs-ramp-covid-19-vaccination-six-fold>
4. B. Impouma *et al.*, "COVID-19 vaccination rollout in the World Health Organization African region: status at end June 2022 and way forward," *Epidemiology & Infection*, vol. 150, p. e143, Jan. 2022, doi: 10.1017/S0950268822001212.
5. J. W. Cabore *et al.*, "COVID-19 in the 47 countries of the WHO African region: a modelling analysis of past trends and future patterns," *The Lancet Global Health*, vol. 10, no. 8, pp. e1099–e1114, Aug. 2022, doi: 10.1016/S2214-109X(22)00233-9.
6. O. Wariri *et al.*, "COVID-19 vaccination implementation in 52 African countries: trajectory and implications for future pandemic preparedness," *BMJ Glob Health*, vol. 8, no. 12, p. e013073, Dec. 2023, doi: 10.1136/bmjgh-2023-013073.
7. Africa CDC, "COVID-19 Vaccination," Africa CDC. Accessed: Apr. 24, 2025. [Online]. Available: <https://africacdc.org/covid-19/covid-19-vaccination/>
8. S. O. Sow *et al.*, "Safety, reactogenicity, and immunogenicity of ZR-202-CoV and ZR-202a-CoV recombinant vaccines compared with Comirnaty®: A randomized, observer-blind, controlled, phase 1 study," *International Journal of Infectious Diseases*, vol. 148, p. 107237, Nov. 2024, doi: 10.1016/j.ijid.2024.107237.
9. Editorials, "Africa is bringing vaccine manufacturing home," *Nature*, vol. 602, no. 7896, pp. 184–184, Feb. 2022, doi: 10.1038/d41586-022-00335-9.
10. G. Makenga, S. Bonoli, E. Montomoli, T. Carrier, and J. Auerbach, "Vaccine Production in Africa: A Feasible Business Model for Capacity Building and Sustainable New Vaccine Introduction," *Front. Public Health*, vol. 7, Mar. 2019, doi: 10.3389/fpubh.2019.00056.
11. R. Warah, "African countries push to produce vaccines locally," ONE.org Africa. Accessed: Sep. 19, 2024. [Online]. Available: <https://www.one.org/africa/stories/africa-produce-covid19-vaccines-locally/>
12. GAVI, "A New Era of Vaccine Manufacturing in Africa." Accessed: Sep. 19, 2024. [Online]. Available: <https://www.gavi.org/news-resources/knowledge-products/new-era-vaccine-manufacturing-africa>
13. Africa CDC, "African Union COVID-19 Vaccination Bingwa Initiative," Africa CDC. Accessed: Apr. 25, 2025. [Online]. Available: <https://africacdc.org/african-union-covid-19-vaccination-bingwa-initiative-2/>
14. A. M. Ekström *et al.*, "Addressing production gaps for vaccines in African countries," *Bull World Health Organ*, vol. 99, no. 12, pp. 910–912, Dec. 2021, doi: 10.2471/BLT.21.287381.
15. J. P. Sinumvayo *et al.*, "Advancing Vaccinology Capacity: Education and Efforts in Vaccine Development and Manufacturing across Africa," *Vaccines (Basel)*, vol. 12, no. 7, p. 741, Jul. 2024, doi: 10.3390/vaccines12070741.
16. Africa CDC, "A Breakthrough for the African Vaccine Manufacturing," Africa CDC. Accessed: Sep. 19, 2024. [Online]. Available: <https://africacdc.org/news-item/a-breakthrough-for-the-african-vaccine-manufacturing/>
17. L. J. Rubin Thompson *et al.*, "Building global vaccine manufacturing capacity: Spotlight on Africa," *Vaccine*, vol. 41, no. 27, pp. 4050–4056, Jun. 2023, doi: 10.1016/j.vaccine.2023.05.009.

18. CEPI, "Research and development | CEPI." Accessed: Sep. 19, 2024. [Online]. Available: <https://cepi.net/research-and-development>
19. J. P. Sinumvayo *et al.*, "Advancing Vaccinology Capacity: Education and Efforts in Vaccine Development and Manufacturing across Africa," *Vaccines*, vol. 12, no. 7, Art. no. 7, Jul. 2024, doi: 10.3390/vaccines12070741.
20. Wellcome, "Scaling up African vaccine manufacturing capacity | Reports," Wellcome. Accessed: Sep. 20, 2024. [Online]. Available: <https://wellcome.org/reports/scaling-african-vaccine-manufacturing-capacity>
21. L. J. Rubin Thompson *et al.*, "Building global vaccine manufacturing capacity: Spotlight on Africa," *Vaccine*, vol. 41, no. 27, pp. 4050–4056, Jun. 2023, doi: 10.1016/j.vaccine.2023.05.009.
22. Africa CDC, "A Breakthrough for the African Vaccine Manufacturing," Africa CDC. Accessed: Apr. 25, 2025. [Online]. Available: <https://africacdc.org/news-item/a-breakthrough-for-the-african-vaccine-manufacturing/>
23. M. Mynhardt *et al.*, "Empowering Africa's healthcare future: The crucial role of human capital development in bio- and pharmaceutical manufacturing," *J Public Health Afr*, vol. 14, no. 10, p. 2866, Dec. 2023, doi: 10.4081/jphia.2024.2866.
24. Africa CDC, "Partnerships for African Vaccine Manufacturing (PAVM) Framework for Action," Africa CDC. Accessed: Sep. 20, 2024. [Online]. Available: <https://africacdc.org/download/partnerships-for-african-vaccine-manufacturing-pavm-framework-for-action/>
25. "African Union and Africa CDC launches Partnerships for African Vaccine Manufacturing (PAVM), framework to achieve it and signs 2 MoUs," Africa CDC. Accessed: Sep. 21, 2024. [Online]. Available: <https://africacdc.org/news-item/african-union-and-africa-cdc-launches-partnerships-for-african-vaccine-manufacturing-pavm-framework-to-achieve-it-and-signs-2-mous/>
26. N. Ndembu, "Africa: a new dawn for local vaccine manufacture," *Nature*, vol. 619, no. 7971, pp. 698–698, Jul. 2023, doi: 10.1038/d41586-023-02316-y.
27. GAVI, "The African Vaccine Manufacturing Accelerator: what is it and why is it important?" Accessed: Sep. 20, 2024. [Online]. Available: <https://www.gavi.org/vaccineswork/african-vaccine-manufacturing-accelerator-what-and-why-important>
28. World Economic Forum, "Regionalized Vaccine Manufacturing Collaborative - Home." Accessed: Sep. 21, 2024. [Online]. Available: <https://initiatives.weforum.org/regionalized-vaccine-manufacturing-collaborative/home>
29. World Economic Forum, "New initiative supports equitable regional vaccine manufacturing," World Economic Forum. Accessed: Sep. 21, 2024. [Online]. Available: <https://www.weforum.org/agenda/2024/01/initiative-supports-equitable-regional-vaccine-manufacturing/>
30. Africa CDC, "Saving Lives and Livelihoods," Africa CDC. Accessed: Apr. 24, 2025. [Online]. Available: <https://africacdc.org/saving-lives-and-livelihoods/>
31. Africa CDC, "Two years on, Saving Lives and Livelihoods initiative administers 32 million COVID-19 Vaccine doses and strengthens health systems in Africa," Africa CDC. Accessed: Apr. 24, 2025. [Online]. Available: <https://africacdc.org/news-item/two-years-on-saving-lives-and-livelihoods-initiative-administers-32-million-covid-19-vaccine-doses-and-strengthens-health-systems-in-africa/>
32. Mastercard Foundation, "Saving Lives and Livelihoods." Accessed: Apr. 24, 2025. [Online]. Available: <https://mastercardfdn.org/en/what-we-do/our-programs/saving-lives-and-livelihoods/>
33. BioNTech, "Modern manufacturing processes for the production of the COVID-19 vaccine." Accessed: Sep. 21, 2024. [Online]. Available: <https://www.biontech.com/int/en/home/manufacturing-and-services/production-network.html>
34. BioNTech, "Update on First BioNTainer for African-based mRNA Manufacturing Facility | BioNTech." Accessed: Sep. 20, 2024. [Online]. Available: <https://investors.biontech.de/news-releases/news-release-details/update-first-biontainer-african-based-mrna-manufacturing-0/>
35. A. A. Saied, "Building Africa's first mRNA vaccine facility," *The Lancet*, vol. 402, no. 10398, pp. 287–288, Jul. 2023, doi: 10.1016/S0140-6736(23)01119-4.
36. A. Irwin, "How COVID spurred Africa to plot a vaccines revolution," *Nature*, Apr. 2021, doi: 10.1038/d41586-021-01048-1.
37. U. Samarasekera, "African vaccine manufacturing scheme to boost production," *The Lancet*, vol. 403, no. 10444, pp. 2579–2580, Jun. 2024, doi: 10.1016/S0140-6736(24)01239-X.
38. V. M. Haakuria, P. C. Munezero, R. Valdes, J. P. Sinumvayo, and L. Mutesa, "Building vaccine and biotherapeutics manufacturing capacity in Africa: a practical approach," *Discov Med*, vol. 2, no. 1, p. 108, Apr. 2025, doi: 10.1007/s44337-025-00313-w.
39. Africa CDC, "Regional Networks to Strengthen Africa's Vaccine and Health Products Manufacturing Workforce," Africa CDC. Accessed: Apr. 25, 2025. [Online]. Available: <https://africacdc.org/news-item/regional-networks-to-strengthen-africas-vaccine-and-health-products-manufacturing-workforce/>
40. B. D. Kana *et al.*, "Opportunities and challenges of leveraging COVID-19 vaccine innovation and technologies for developing sustainable vaccine manufacturing capabilities in Africa," *The Lancet Infectious Diseases*, vol. 23, no. 8, pp. e288–e300, Aug. 2023, doi: 10.1016/S1473-3099(22)00878-7.
41. S. Plotkin, J. M. Robinson, G. Cunningham, R. Iqbal, and S. Larsen, "The complexity and cost of vaccine manufacturing

- An overview,” *Vaccine*, vol. 35, no. 33, pp. 4064–4071, Jul. 2017, doi: 10.1016/j.vaccine.2017.06.003.
42. H. Onywera *et al.*, “Boosting pathogen genomics and bioinformatics workforce in Africa,” *The Lancet Infectious Diseases*, vol. 24, no. 2, pp. e106–e112, Feb. 2024, doi: 10.1016/S1473-3099(23)00394-8.
43. G. Makenga, R. Booy, P. N. Oloo, and J. Auerbach, “COVID-19 vaccine development, production and regulatory oversight in African countries,” *Bull World Health Organ*, vol. 100, no. 10, pp. 651–652, Oct. 2022, doi: 10.2471/BLT.22.287958.
44. I. Aniebo, “Investment in African research and development will boost health and economic growth,” *Nat Med*, vol. 30, no. 2, pp. 326–326, Feb. 2024, doi: 10.1038/s41591-023-02746-1.
45. A. J.-J. Owolade *et al.*, “Strengthening Africa’s capacity for vaccine research: Needs and challenges,” *Health Promot Perspect*, vol. 12, no. 3, pp. 282–285, Dec. 2022, doi: 10.34172/hpp.2022.36.
46. NIH *et al.*, “Critical Components for Vaccine Manufacturing,” in *Globally Resilient Supply Chains for Seasonal and Pandemic Influenza Vaccines*, National Academies Press (US), 2021. Accessed: Sep. 22, 2024. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK580000/>
47. H. Mogoje, “Current and planned vaccine manufacturing in Africa,” Clinton Health Access Initiative. Accessed: Sep. 22, 2024. [Online]. Available: <https://www.clintonhealthaccess.org/report/current-and-planned-vaccine-manufacturing/>
48. K. Cullinan, “Despite Hosting mRNA Hub, South Africa Buys Vaccines From India – Highlighting Tension Between Price Pressures And Local Production - Health Policy Watch.” Accessed: Sep. 21, 2024. [Online]. Available: <https://healthpolicy-watch.news/despite-hosting-mrna-hub-south-africa-buys-vaccines-from-india-highlighting-tension-between-price-and-local-production/>
49. Africa CDC, “Addressing Regulatory Challenges to Advance Local Manufacturing in Africa,” Africa CDC. Accessed: Sep. 22, 2024. [Online]. Available: <https://africacdc.org/news-item/addressing-regulatory-challenges-to-advance-local-manufacturing-in-africa/>
50. H. Akegbe *et al.*, “The need for Africa to develop capacity for vaccinology as a means of curbing antimicrobial resistance,” *Vaccine: X*, vol. 14, p. 100320, Aug. 2023, doi: 10.1016/j.jvacx.2023.100320.
51. “African Medicines Agency (AMA) | AUDA-NEPAD-AMRH.” Accessed: Sep. 22, 2024. [Online]. Available: <https://amrh.nepad.org/african-medicines-agency-ama>

Table 2. Regional Vaccine Manufacturing Initiatives and Progress

Initiative	Leading Organisation	Focus Areas	Geographic Reach	Progress/Status
PAVM (Partnerships for African Vaccine Manufacturing)	Africa CDC	Regulation, IP transfer, procurement	Pan-African	Framework active since 2021
AVMA (African Vaccine Manufacturing Accelerator)	GAVI	Financial incentives, capacity development	Africa-wide	Launched in 2023, \$1B pledged
RVMC (Regionalized Vaccine Manufacturing Collaborative)	CEPI/WEF	Resilient regional facilities	LMICs	Initial \$15M, pilot in Africa
BioNTech mRNA Facility	BioNTech	mRNA COVID-19 vaccines	Rwanda, Senegal, SA	First node launched in Kigali
Saving Lives & Livelihoods	Africa CDC/Mastercard	Distribution, Training	30+ AU member states	Cold chains expanded, 2021–2024