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International Cotton Advisory Committee



SPECIAL ISSUE

COTTON BY NUMBERS

Global Trends & Insights from the ICAC Cotton Data Book 2026

Editorial

Cotton in Numbers: Beyond Perceptions, Towards Evidence

Cotton is a remarkable symbol of resilience, adaptability and survival. Few crops demonstrate such extraordinary ecological versatility. Cotton grows in the scorching deserts of Central Asia and Australia, as well as in the humid tropics and semi-arid regions of Africa and India. Its deep root system and tolerance to heat and moisture stress enable it to survive in some of the harshest environments on Earth. In January 2019, cotton's resilience reached a new frontier when a seed aboard China's Chang'e-4 spacecraft became the first to germinate on the lunar surface, inside a controlled biological chamber. Although the seedling survived briefly, the experiment marked a milestone in extraterrestrial plant biology. Ironically, this remarkably resilient crop has been subjected to persistent misinformation campaigns portraying it as one of the world's thirstiest and most chemical-intensive crops.

This special edition, Cotton in Numbers, presents selected insights from the ICAC Cotton Data Book 2026, the outcome of a year-long effort to compile and validate reliable data from 38–42 countries accounting for over 99% of global cotton production. Covering cultivation, input use, harvesting, ginning, fibre characteristics, trade and by-products, the Data Book draws upon detailed state- and provincial-level information for the 2025 crop, sourced from ICAC coordinating agencies, governments, research institutions, official databases and scientific literature.

The datasets reveal cotton's extraordinary contribution to livelihoods. In 2025, more than 20 million farmers cultivated cotton, approximately 30% of whom were women. Interestingly, nearly 99% of cotton farmers are smallholders cultivating less than 1.5 hectares, predominantly in Africa and Asia. The sector supported an estimated 125 million full-time-equivalent jobs and generated 4.74 billion person-days of on-farm employment. Labour requirements, however, vary enormously, from approximately one person-day per hectare on highly mechanised farms in the United States and Australia to 329 in India. Nearly 68% of global cotton is still harvested manually. With rising wages and labour shortages, affordable smallholder mechanisation is becoming increasingly essential.

Perhaps no aspect of cotton has attracted greater criticism than water consumption. Cotton is frequently portrayed as excessively water-intensive, whereas approximately half of the global cotton area is cultivated entirely under rainfed conditions. A 150–180-day cotton crop typically requires 600–700 mm of water, broadly comparable to maize, wheat, soybean and sunflower, and considerably less than long-duration crops such as sugarcane and banana. Irrigation becomes essential primarily in arid regions, where effective seasonal rainfall is barely 10 mm in Egypt, 26 mm in Turkmenistan and 48 mm in Uzbekistan. In contrast, Brazil and much of Africa produce cotton predominantly under rainfall. Nearly 80% of global cotton irrigation water use is concentrated in a handful of countries. The average consumptive irrigation footprint is estimated at 2,440 litres per kilogram of lint, with enormous regional variations. The critical concern, therefore, is not merely how much water cotton consumes, but its source, availability and efficiency of utilisation.

Agrochemical use presents another important challenge. Cotton occupies approximately 2.4% of global arable land but accounts for 3.8% of fertilizer use, 3.5% of pesticide use, 10.5% of insecticide use and 13% of highly hazardous pesticide use. These disproportionate shares warrant serious attention through integrated pest management, resistance management and elimination of hazardous products. Nevertheless, insecticide use declined by 30–50% in several countries following Bt cotton adoption. Interestingly, insecticide use per hectare is currently 1.5–2 times higher in fruits, nuts, vegetables and rice than in cotton. Banana cultivation uses approximately twice as much highly hazardous pesticide per hectare, while grapes may require five to six times more total pesticide. Such comparisons highlight the importance of balanced, crop-specific assessments.

The greatest opportunity for improving sustainability lies in productivity. Global lint yield averages 866 kg per hectare, ranging from 2,391 kg in Australia to 431 kg in India and below 200 kg in parts of sub-Saharan Africa. Low input use does not necessarily ensure economical or environmentally efficient production when yields remain poor. Improving varieties, soil health, nutrition, water management and mechanisation can substantially increase farmer incomes while reducing the environmental footprint per kilogram of fibre.

Numbers alone do not change farming. They do, however, reveal where to look, what to measure, what to question and what needs to change. Cotton has long been subjected to misleading narratives concerning water consumption, pesticide use and greenhouse gas emissions, often based on broad assumptions and extrapolations rather than representative field-level evidence. Genuine sustainability concerns must certainly be addressed, but perceptions should not overshadow cotton's immense contribution to rural livelihoods and economies.

The ICAC Cotton Data Book 2026 offers a credible foundation for scientifically rigorous assessments. We invite researchers, policymakers and the wider cotton community to examine these datasets and translate the evidence into practical improvements. The future of cotton must be shaped by credible science, not misleading narratives; by evidence, not assumptions; and by measurable improvements, not perceptions. This is essential to safeguard this remarkable natural fibre and the livelihoods of millions of smallholder farmers who depend upon it.

-Keshav Kranthi

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The ICAC Recorder

Cotton By Numbers

Global Trends & Insights from the ICAC Cotton Data Book 2026

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INTRODUCTION

Cotton is the world's most important natural fibre crop. It is also one of the few agricultural commodities that links smallholder fields directly to global industrial supply chains. Besides lint for the textile industry, the crop yields cottonseed, a source of edible oil and protein-rich livestock feed, as well as stalks that can be returned to the soil or converted into compost and biochar. For millions of farming households in Asia and Africa, cotton is a principal cash crop and an important source of rural employment. In the Americas and Australia, it is a capital-intensive commercial enterprise. This dual identity makes cotton a useful case for examining how production systems shape productivity, profitability and sustainability.

Globally, cotton occupies about 29.4 million hectares, but cultivation is highly concentrated. India alone accounts for 39% of the world's cotton area. Five countries (India, the United States, China, Brazil and Pakistan) together account for about 74%. Area, however, is a poor guide to output. Lint yields range from 2,391 kg/ha in Australia to just 83 kg/ha in Zambia. India, the country with the largest cotton area, achieves only 431 kg/ha, about half the global average of 866 kg/ha. These disparities suggest that cotton performance depends less on land endowment than on how the crop is grown: farm size, mechanisation, access to irrigation, input use, crop management and institutional support.

The world's cotton systems can be broadly grouped into two contrasting models. The first comprises large, mechanised, capital-intensive farms, typified by Australia, Brazil, Argentina and the United States. Here average holdings exceed 180 hectares, planting and harvesting are almost fully mechanised, weeds are controlled chemically, and labour requirements fall to as little as one man-day per hectare. The second comprises smallholder systems across South Asia and sub-Saharan Africa. These have holdings of one to four hectares and rely mainly on manual planting, weeding and picking. Irrigation is limited and, in much of Africa, fertilizer and pesticide use is extremely low. Between these extremes lie the intensive irrigated systems of China, Türkiye, Egypt and Central Asia. They combine small or medium holdings with heavy input use and, increasingly, with mechanisation.

These contrasts have consequences well beyond yield. Labour-intensive systems leave farmers exposed to rising wages and seasonal labour shortages, and much of the burden of weeding and picking falls on women and family members. Input-intensive systems raise concerns about nutrient losses, pesticide loads, herbicide resistance and greenhouse gas emissions. Irrigated cotton in arid regions draws heavily on scarce freshwater. Residue burning and the limited adoption of conservation tillage are missed opportunities to improve soil health and sequester carbon. Economically, high expenditure per hectare does not necessarily mean a high cost per kilogram of lint, and low-input farming does not guarantee cheap or profitable cotton. Competitiveness can therefore be understood only by examining costs alongside yields, ginning outturn and net returns.

Despite cotton's significance, cross-country comparisons of production systems are often confined to area, production and yield. Fewer analyses bring together labour use, mechanisation, input intensity, cost structure, profitability and resource-use indicators on a common basis. An integrated view of this kind is needed to identify where yield gaps arise and which constraints are binding in different systems. It also shows which interventions are likely to deliver the greatest returns, whether improved varieties, smallholder-appropriate mechanisation, integrated weed and pest management, balanced nutrition or efficient irrigation.

This study analyses a cross-country dataset covering 42 cotton-producing countries. It examines:

- The distribution of cotton area and lint yield.
- Farm structure, labour requirements and the extent of mechanisation in planting, weeding and harvesting.
- The use of fertilizers, herbicides and insecticides.
- The structure of cultivation costs, net returns and production costs per kilogram of seed cotton and lint.
- Environmental indicators, including conservation tillage, residue burning, effective rainfall and the irrigation water footprint.

The aim is to identify the principal sources of productivity and cost differences among countries. It also highlights pathways towards more productive, profitable and sustainable cotton production, particularly for smallholder farmers.

GLOBAL COTTON AREA (hectares) & PRODUCTIVITY (kg/ha)

Fig-1. Cotton Area (x1000 hectares)

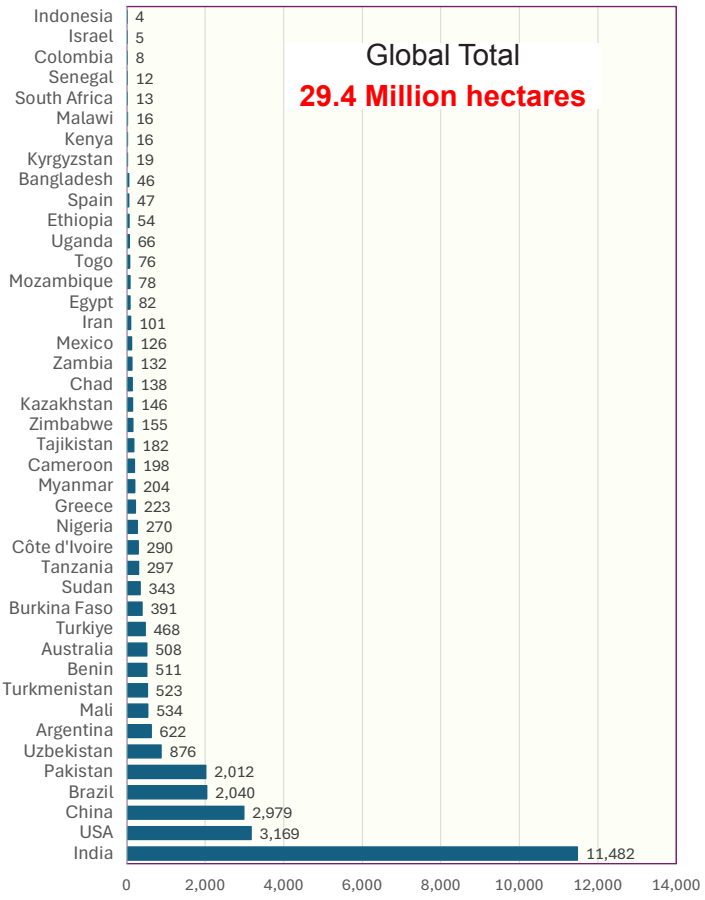
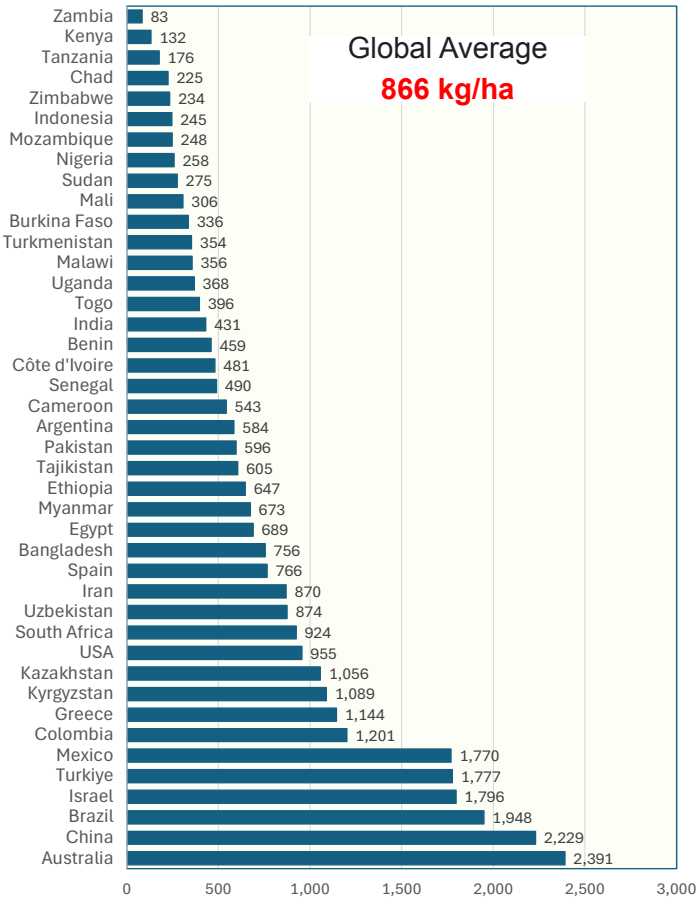


Fig-2. Cotton Yield (kg/ha)



Global Cotton Area:
Distribution Across Major Producing Countries

The global cotton area is estimated at 29.4 million hectares, with cultivation concentrated in a few major producing countries. India dominates with 11.48 million hectares, accounting for 39.1% of the global area, substantially exceeding all other countries. The United States ranks second with 3.17 million hectares (10.8%), followed by China with 2.98 million hectares (10.1%).

Brazil and Pakistan cultivate approximately 2.04 million and 2.01 million hectares, respectively, each contributing nearly 7%. Together, these five countries account for approximately 74% of the world's cotton area, highlighting the geographical concentration of cotton cultivation. Uzbekistan follows with 0.88 million hectares, while Argentina, Mali, Turkmenistan, Benin and Australia each cultivate between 0.5 and 0.6 million hectares. Across Africa, cotton cultivation is distributed among several countries, predominantly smallholder-based production systems.

The considerable differences in cotton area among countries reflect variations in agroecological conditions, farming systems, irrigation availability and the economic importance of cotton in national agriculture.

Global Cotton Yield (lint kg/ha):
Wide Disparities in Lint Yields

Global cotton productivity averages 866 kg lint per hectare, with substantial disparities across countries, reflecting differences in production systems, irrigation, technology adoption and crop management. Australia leads with an impressive 2,391 kg/ha, followed by China (2,229 kg/ha), Brazil (1,948 kg/ha), Israel (1,796 kg/ha), Türkiye (1,777 kg/ha) and Mexico (1,770 kg/ha).

These countries achieve more than twice the global average, demonstrating the potential of advanced production systems. In contrast, India, despite having the world's largest cotton area, records only 431 kg/ha, approximately half the global average. Productivity is particularly low across sub-Saharan Africa, with Zambia (83 kg/ha), Kenya (132 kg/ha), Tanzania (176 kg/ha) and Chad (225 kg/ha) among the lowest. Pakistan (596 kg/ha) and several Central

Asian countries also remain below the global average. These striking productivity gaps highlight considerable opportunities to improve cotton yields through better varieties, improved soil health, efficient water management and scientifically informed agronomic practices.

LAND HOLDING SIZE (ha/farmer) & LABOUR EMPLOYED IN COTTON (man-days/ha)

Fig-3. Land Holding Size (hectares) per Farmer

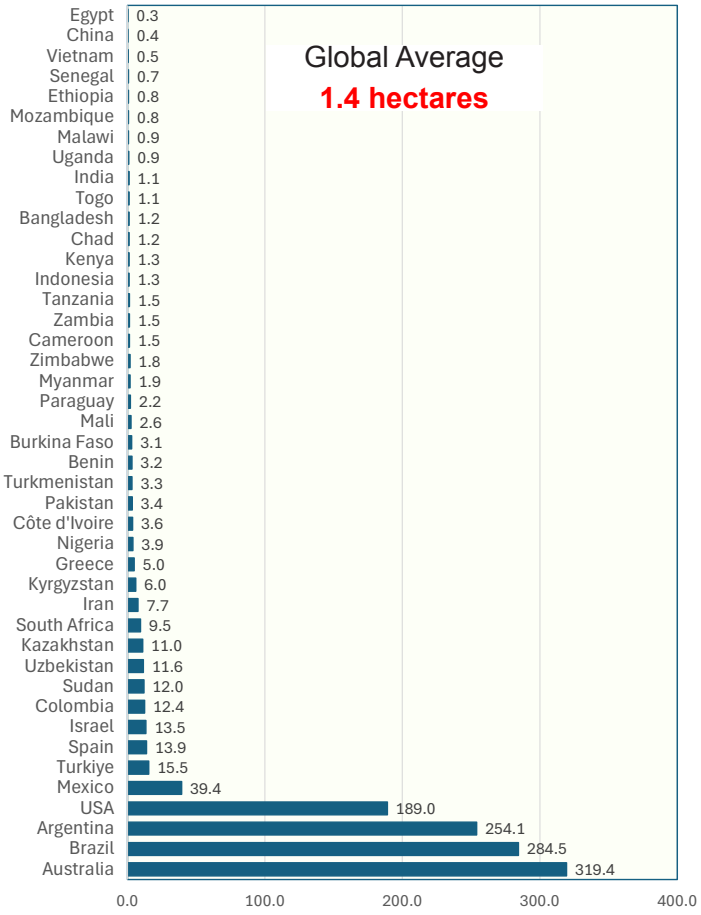
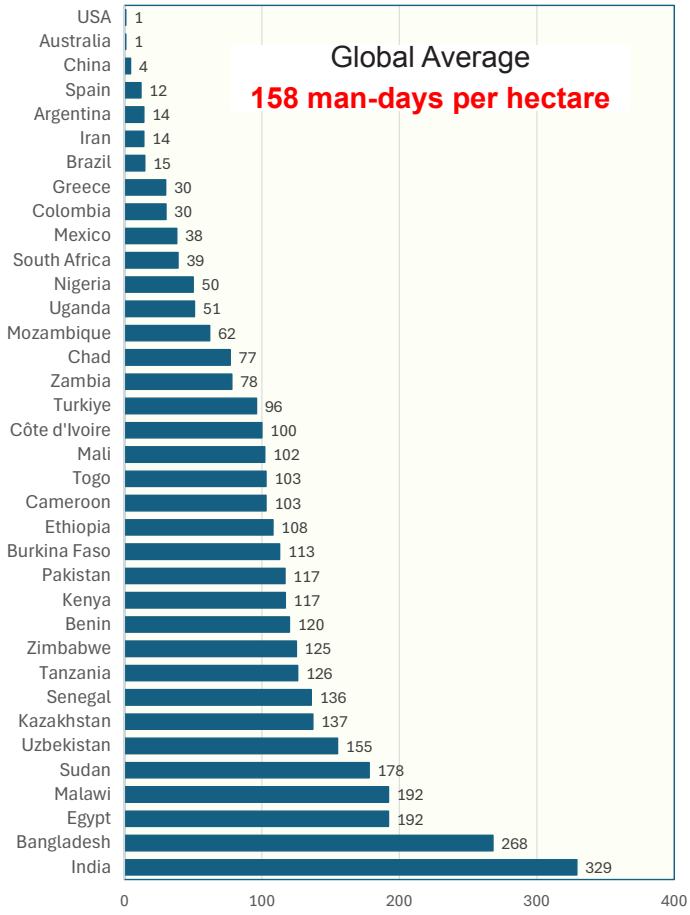


Fig-4. Labour Employed for Cotton Production (Man-days/ha)



Global Cotton Farm Holdings (hectares): Wide Disparities in Farm Sizes

The global average cotton farm holding is 1.4 hectares per farmer or family, reflecting the predominance of smallholder agriculture, particularly in Asia and Africa. However, farm sizes vary enormously across countries. Australia has the largest average cotton farm size at 319.4 hectares, followed by Brazil (284.5 ha), Argentina (254.1 ha) and the United States (189.0 ha), reflecting predominantly large-scale, mechanised commercial farming. In contrast, cotton cultivation in Asia and Africa is largely characterised by small and fragmented holdings. Average farm sizes are particularly small in Egypt (0.3 ha), China (0.4 ha), Ethiopia (0.8 ha) and India (1.1 ha). Most African cotton-producing countries have holdings below four hectares, although considerable variations exist. Pakistan averages 3.4 hectares, while Uzbekistan and Türkiye have relatively larger holdings of 11.6 and 15.5 hectares, respectively.

These striking differences influence mechanisation, labour requirements, production costs and technology adoption, highlighting the need for farm-size-specific strategies to improve cotton productivity, profitability and sustainability.

Employment of Labour in Cotton Farms: Farming in Asia and Africa is Labour Intensive

Cotton production presents a striking contrast in labour intensity across the world, with a global average of 158 man-days per hectare. At one extreme, highly mechanised systems in the United States and Australia require just one man-day per hectare, while China records four, and Brazil 15. At the other extreme, India requires an extraordinary 329 man-days per hectare, more than twice the global average, followed by Bangladesh (268), Egypt (192) and Malawi (192). Across Africa, labour requirements vary considerably, from 50 man-days in Nigeria to 136 in Senegal, reflecting differences in farming practices and mechanisation. Pakistan (117), Türkiye (96) and Uzbekistan (155) occupy intermediate positions.

These disparities reveal more than differences in technology: they underscore the dependence of millions of smallholder farmers on manual operations, particularly weeding and harvesting. While mechanisation offers opportunities to reduce production costs and labour shortages, affordable, smallholder-appropriate machinery and collective mechanisation services will be essential for improving efficiency without undermining rural livelihoods.

LABOUR EMPLOYED FOR COTTON PRODUCTION (man-days per hectare)

Fig-5. Labour for Weeding (Man-days per hectare)

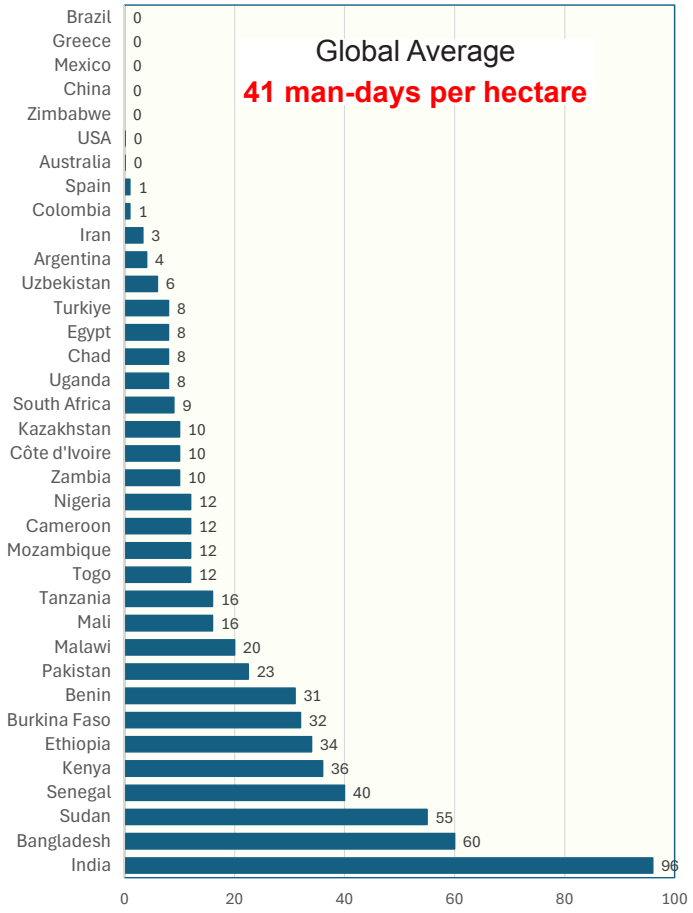
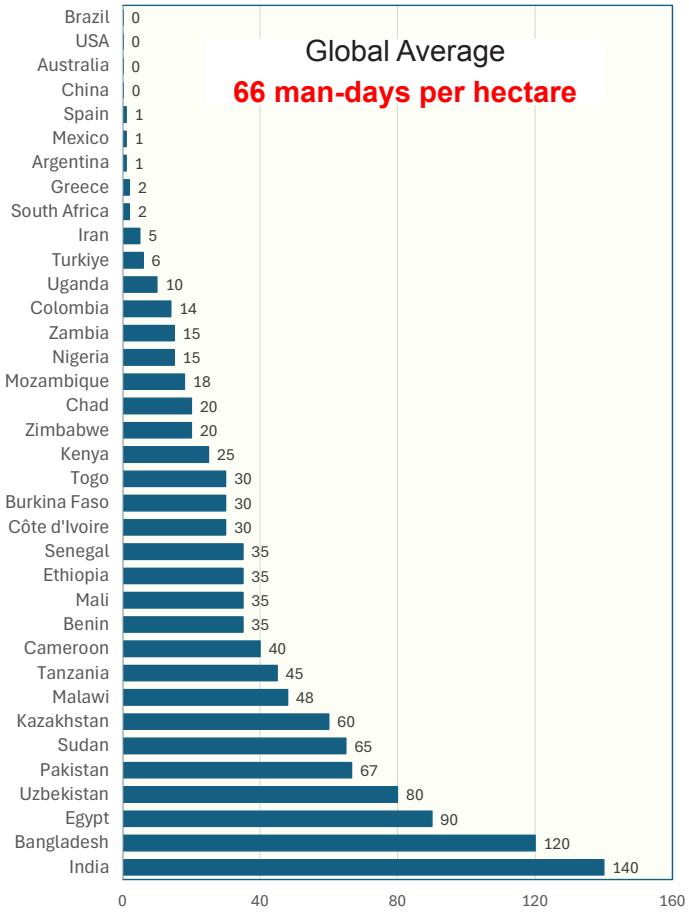


Fig-6. Labour for Picking (Man-days per hectare)



Labour for Weeding:
The Hidden Burden of Cotton Cultivation.

Weeding remains one of the most labour-intensive operations in cotton cultivation, with a global average of 41 man-days per hectare. Yet, the burden is far from evenly distributed. India stands out with an exceptionally high requirement of 96 man-days per hectare, more than twice the global average, followed by Bangladesh (60) and Sudan (55). Across Africa, the picture is mixed, with Senegal (40), Kenya (36), Ethiopia (34), Burkina Faso (32) and Benin (31) recording substantial labour requirements. In sharp contrast, Brazil, China, Australia and the United States report virtually no manual weeding, reflecting the widespread adoption of herbicides and mechanised weed management.

Interestingly, Zimbabwe also reports zero manual weeding days, despite its predominantly smallholder farming systems. These disparities highlight the enormous economic and physical burden of manual weed control, particularly on women and smallholder families. Improved agronomic practices, small-scale affordable mechanical weeders and integrated weed management could substantially reduce labour costs, ease drudgery and improve cotton profitability.

Labour for Cotton Picking:
Mechanization Could Make a Huge Difference.

Cotton harvesting reveals one of the sharpest contrasts between mechanised and labour-dependent farming systems.

Against a global average of 66 man-days per hectare, India requires 140 man-days, followed by Bangladesh (120), Egypt (90) and Uzbekistan (80). These high labour requirements reflect the continued dependence on manual picking, often involving multiple harvest rounds. At the opposite extreme, Brazil, the United States, Australia and China report virtually no manual picking labour, reflecting extensive mechanisation. Türkiye (6), Argentina (1) and Mexico (1) also demonstrate remarkably low labour requirements. Across Africa, picking generally requires 10–48 man-days per hectare, with Malawi (48), Tanzania (45) and Cameroon (40) among the more labour-intensive countries. Interestingly, India's picking labour requirement alone exceeds the total labour used for all cotton operations in several countries. The challenge for smallholder cotton economies is not merely mechanisation, but developing affordable harvesting technologies, supported by suitable plant architecture, synchronised boll maturity and improved defoliation practices.

COTTON PRODUCTION PRACTICES

Fig-7. Manual Planting (%)

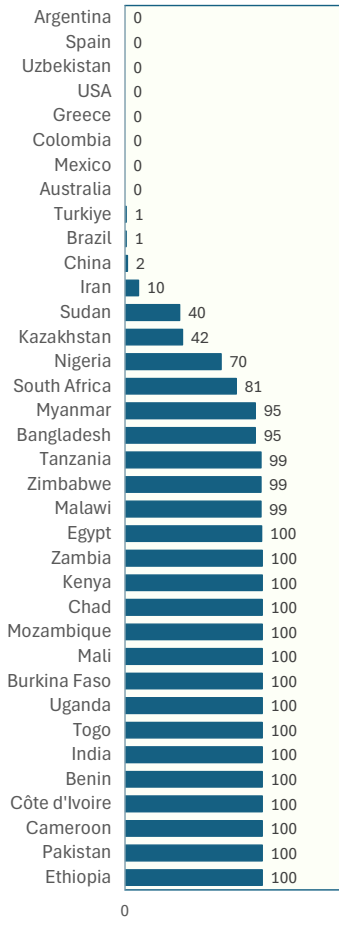


Fig-8. Manual Weeding(%)

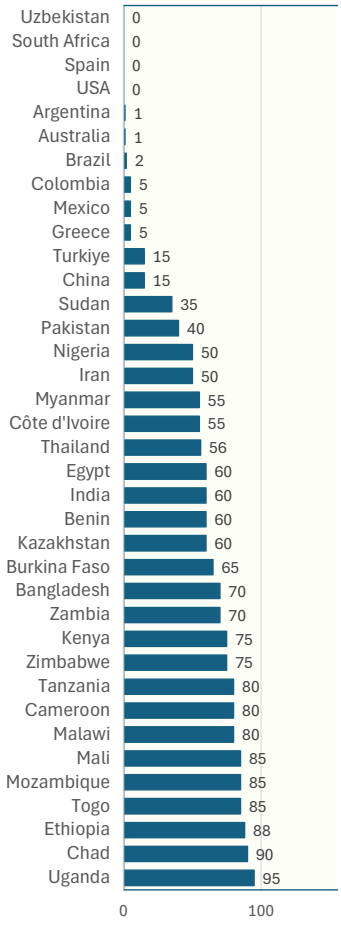


Fig-9. Manual Picking (%)

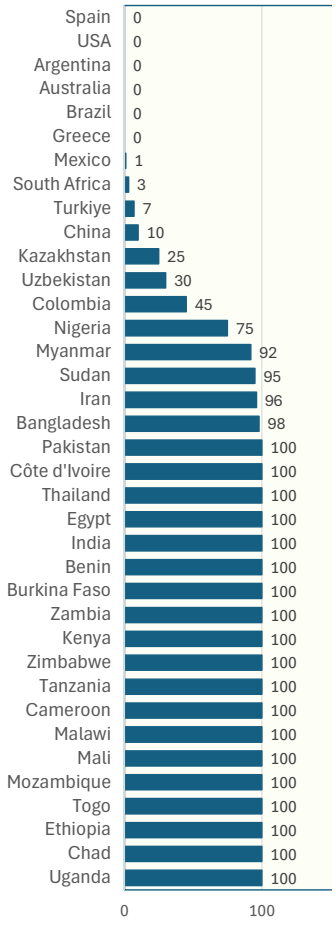
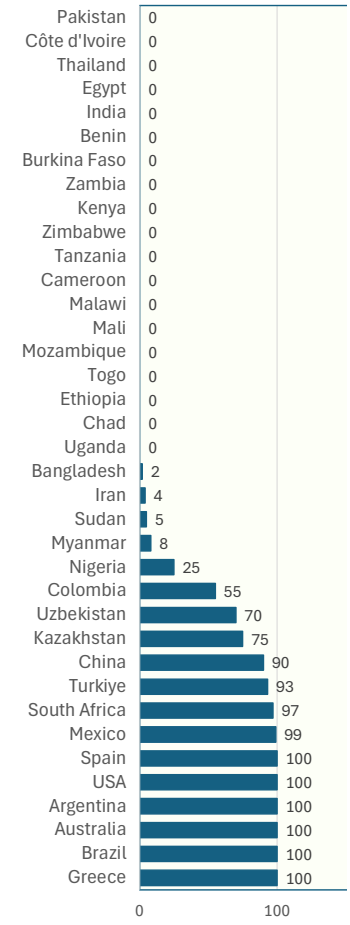


Fig-10. Machine Picking (%)



Manual Planting:

Despite advances in agricultural mechanisation, 51% of global cotton planting is still performed manually. India, Pakistan, Egypt and numerous African countries report 100% manual planting, highlighting the predominance of labour-dependent smallholder systems. Bangladesh records 95%, while Nigeria stands at 70%. Conversely, planting is almost entirely mechanised in the United States, Australia, Brazil, China and Türkiye. The data highlight the need for affordable precision seeders and small-scale planting equipment to improve crop establishment & planting efficiency and labour productivity.

Manual Weeding:

Globally, 40% of cotton weeding is performed manually, but dependence varies dramatically across countries. Uganda (95%), Chad (90%) and Ethiopia (88%) lead, while India, Egypt and Benin each report 60%. In contrast, manual weeding is virtually absent in the United States, Australia, Brazil and Uzbekistan. The divide reflects differences in mechanisation, herbicide use and access to labour-saving technologies. Affordable mechanical weeders and integrated weed management could substantially reduce production costs.

Manual Picking:

Nearly 68% of the world's cotton is harvested by hand, making picking a major labour-intensive operation. India, Pakistan, Egypt and most African cotton-producing countries depend entirely on manual harvesting. Bangladesh records 98%, while Uzbekistan (30%) and Kazakhstan (25%) demonstrate partial mechanisation. China has reduced manual harvesting to 10%. With global picking labour averaging 66 man-days per hectare, the continued dependence on hand-picking exposes smallholder farmers to rising labour costs, seasonal shortages and delayed harvesting.

Machine Harvesting:

Machine harvesting accounts for 32% of global cotton production. Cotton picking in USA, Australia, Brazil, Argentina, Spain & Greece is 100% mechanised, followed by Mexico (99%), South Africa (97%), Türkiye (93%) and China (90%). Uzbekistan (70%) and Kazakhstan (75%). Conversely, cotton in India, Pakistan & most African countries is 100% hand picked. Expanding mechanisation in smallholder systems requires suitable cotton varieties, affordable machinery, custom-hiring services compatible with mechanical harvesting.

COTTON PRODUCTION PRACTICES

Fig-11. Ginning (%)

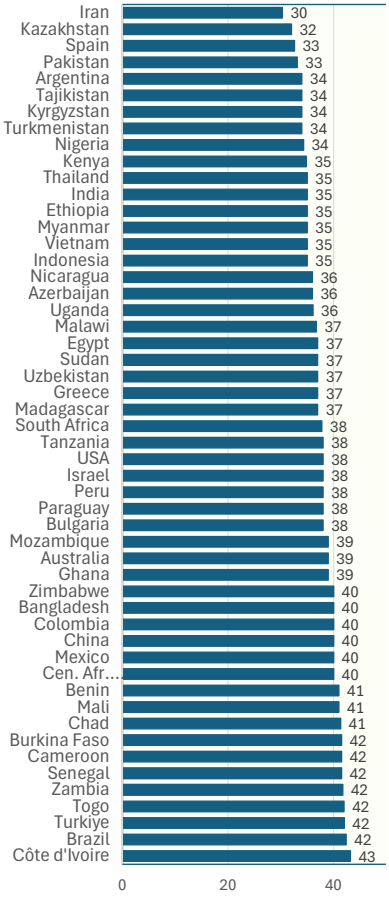


Fig-12. Seeds Crushed for Oil (%)

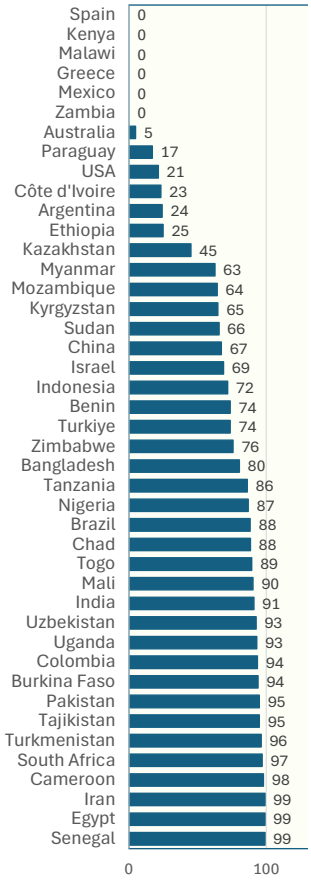


Fig-13. Conservation Till (%)

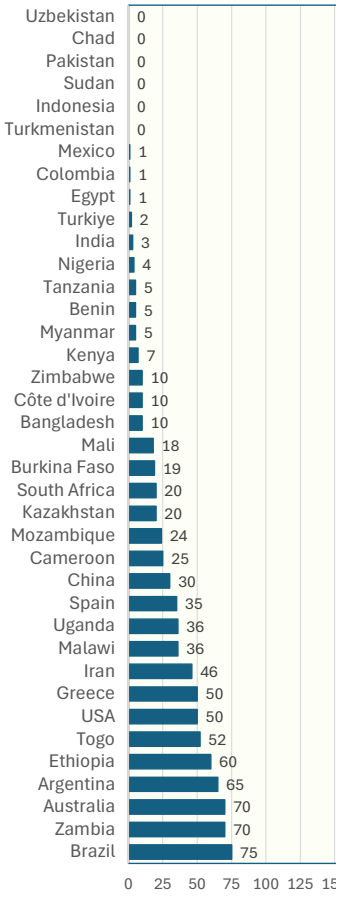
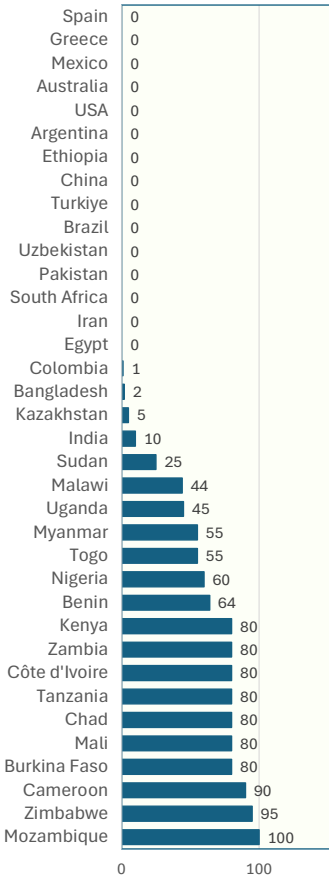


Fig-14. Cotton Stalks Burnt in Fields (%)



Ginning %:

The global average ginning percentage is 37%, indicating that approximately 37 kg of lint is recovered from 100 kg of seed cotton. Côte d'Ivoire records the highest ginning outturn (43%), followed by Brazil, Türkiye, Zambia and Cameroon (42%). China achieves 40%, while India averages 35%. Iran (30%) and Kazakhstan (32%) record the lowest values. These differences reflect varietal characteristics, seed-to-lint ratios and fibre properties, highlighting the importance of breeding for higher lint recovery without compromising fibre quality.

Seeds Crushed for Oil %:

Globally, approximately 69% of cottonseed is crushed for oil extraction, making cottonseed an important source of edible oil and protein-rich livestock feed. Crushing rates approach 99% in Egypt, Iran and Senegal, followed by Cameroon (98%), Pakistan (95%) and India (91%). Surprisingly, Australia (5%) and the United States (21%) record relatively low crushing percentages. Several countries, including Kenya, Malawi and Zambia, do not crush cotton seeds. These contrasts highlight differences in processing infrastructure, domestic demand and alternative cottonseed utilisation.

Conservation Tillage %:

Conservation tillage covers only 18% of the global cotton area, indicating considerable scope for adopting soil-conserving practices. Brazil leads with 75%, followed by Australia and Zambia (70%), Argentina (65%) and Ethiopia (60%). The United States and Greece each report 50%. In contrast, India (3%), Pakistan (0%), Türkiye (2%) and Uzbekistan (0%) show minimal adoption. Wider adoption of regenerative agriculture practices could improve soil structure, reduce erosion and enhance water-use efficiency.

Cotton Stalks Burnt in Fields %:

An estimated 13% of cotton stalks are burnt in fields globally, but the practice is heavily concentrated in certain countries. Mozambique reports 100% burning, followed by Zimbabwe (95%), Cameroon (90%) and several African countries at 80%. India records 10%, while Brazil, China, Australia and the United States report none. Beyond air pollution and nutrient losses, burning represents a missed opportunity to convert cotton residues into biochar, compost and other valuable products, potentially improving soil health and generating carbon-removal benefits.

FERTILIZER USAGE IN COTTON PRODUCTION (kg per hectare)

Fig-15. Nitrogenous Fertilizer (kg per hectare)

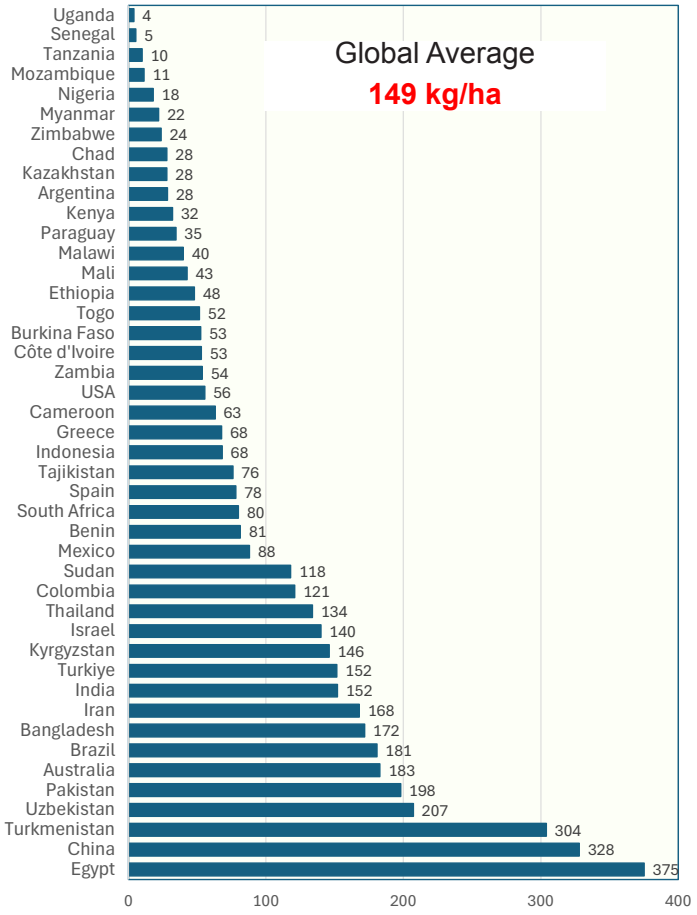
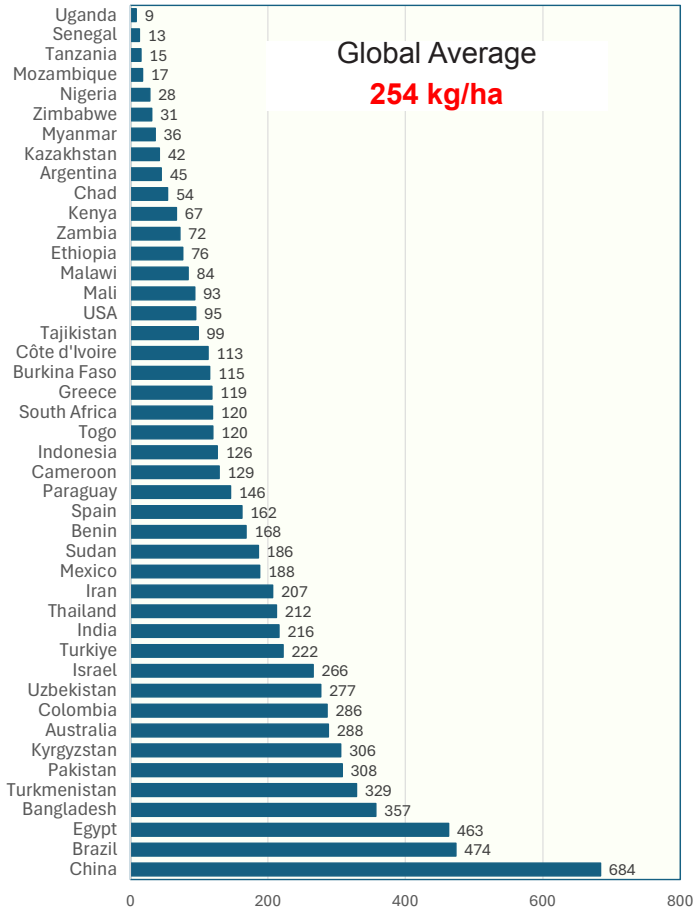


Fig-16.NPK Fertilizer (kg per hectare)



Nitrogenous Fertilizer Usage (kg/ha):

Nitrogen fertilizer use in cotton cultivation varies enormously across countries, against a global average of 149 kg N/ha. Egypt leads with an exceptionally high application rate of 375 kg/ha, followed by China (328), Turkmenistan (304), Uzbekistan (207) and Pakistan (198). Brazil (181) and Australia (183) also record relatively high nitrogen inputs, while India (152) remains close to the global average. In sharp contrast, nitrogen application is extremely low across much of sub-Saharan Africa, particularly Uganda (4), Senegal (5), Tanzania (10) and Mozambique (11 kg/ha). Interestingly, the United States applies only 56 kg/ha, demonstrating that high cotton productivity does not necessarily require excessive nitrogen inputs. These disparities reflect differences in soil fertility, yield expectations, irrigation, fertilizer accessibility and nutrient management practices.

While inadequate nitrogen limits productivity in many smallholder systems, excessive application can increase production costs, nitrate leaching and nitrous oxide emissions. Improving nitrogen-use efficiency through soil testing, balanced fertilization and precision nutrient management is therefore essential for sustainable cotton production.

NPK Fertilizer Usage (kg/ha):

The global average application of nitrogen, phosphorus and potassium (NPK) nutrients in cotton is 254 kg/ha, concealing remarkable differences in fertilizer-use intensity. China stands out at 684 kg/ha, nearly 2.7 times the global average, followed by Brazil (474), Egypt (463) and Bangladesh (357). Turkmenistan (329), Pakistan (308) and Australia (288) also record relatively high nutrient inputs. India applies 216 kg/ha, moderately below the global average, while the United States records just 95 kg/ha. At the other extreme, Uganda (9), Senegal (13), Tanzania (15) and Mozambique (17) apply negligible quantities, indicating severe limitations in nutrient replenishment across many African cotton systems.

Such disparities underscore the contrasting challenges of nutrient depletion in low-input agriculture and potential overfertilization in intensive production systems. Importantly, higher fertilizer application does not automatically translate into proportionately higher yields. Balanced nutrient management, improved soil organic matter, efficient fertilizer placement and site-specific recommendations offer considerable opportunities to improve nutrient-use efficiency, profitability and environmental sustainability.

PESTICIDE USAGE IN COTTON PRODUCTION (kg per hectare)

Fig-17. Herbicides (kg/ha)

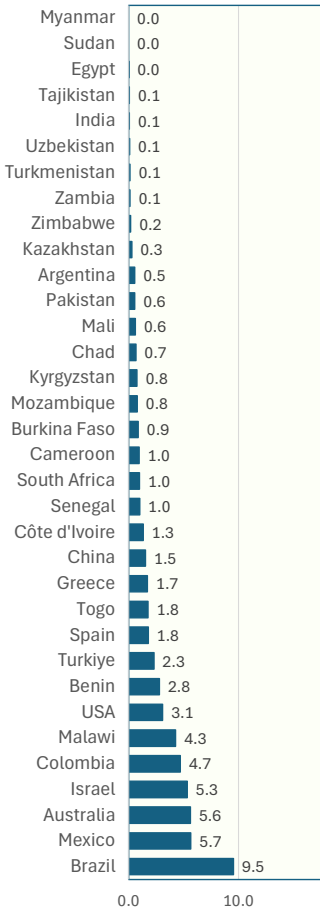


Fig-18. Insecticides (kg/ha)

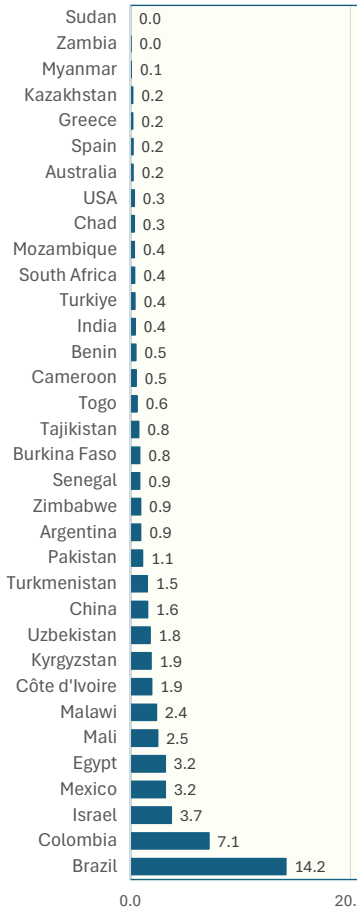
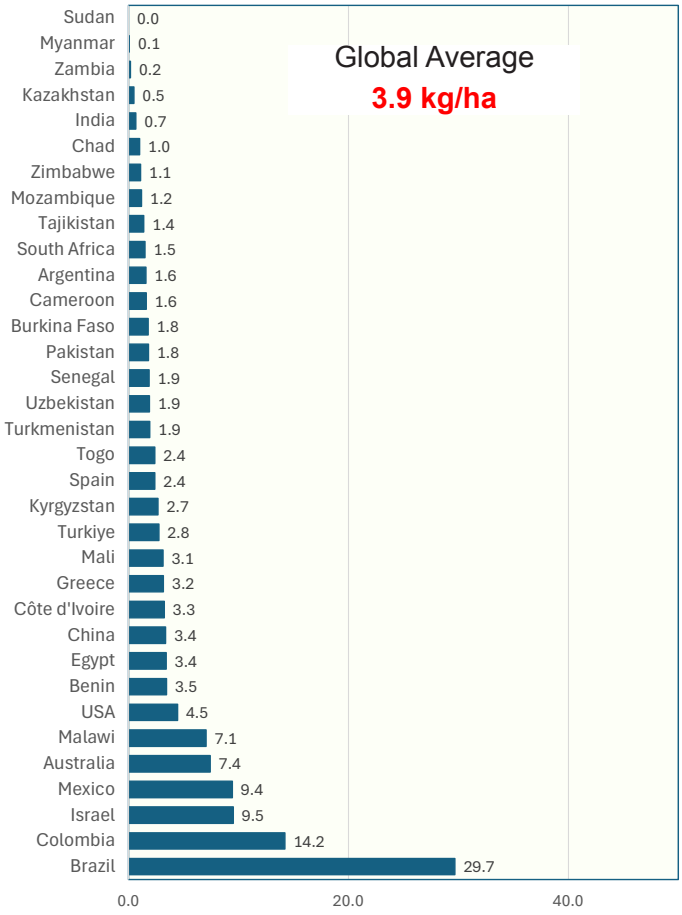


Fig-19. Pesticides (kg/ha)



Herbicide Usage (kg/ha):

Global herbicide use in cotton averages 1.5 kg/ha, with striking differences among countries. Brazil leads at 9.5 kg/ha, followed by Mexico (5.7), Australia (5.6) and Israel (5.3). The United States applies 3.1 kg/ha, while China matches the global average. In contrast, India uses only 0.1 kg/ha, reflecting its greater dependence on manual weeding. These disparities highlight opportunities for integrated weed management that balances labour efficiency, herbicide resistance risks and environmental sustainability.

Insecticide Usage (kg/ha):

Cotton insecticide use averages 1.7 kg/ha globally, but application intensity differs considerably. Brazil records an exceptionally high 14.2 kg/ha, followed by Colombia (7.1), Israel (3.7), Egypt and Mexico (3.2 each). China (1.6) remains close to the global average, while India (0.4), the United States (0.3) and Australia (0.2) report relatively low usage. These differences reflect contrasting pest pressures, cropping environments and management strategies, underscoring the importance of integrated pest management and resistance management.

Total Pesticide Usage in Cotton (kg/ha):

Global cotton cultivation uses an average of 3.9 kg of pesticides per hectare, with enormous differences in application intensity. Brazil stands out at 29.7 kg/ha, nearly eight times the global average, followed by Colombia (14.2), Israel (9.5), Mexico (9.4) and Australia (7.4). The United States applies 4.5 kg/ha, while China (3.4) and Egypt (3.4) remain slightly below the global average. India, despite having the world's largest cotton area, uses only 0.7 kg/ha, considerably below the global average. Several African countries also report relatively low pesticide inputs, although Malawi records 7.1 kg/ha.

Cotton cultivation accounts for approximately 113,949 tonnes of pesticides annually (data not presented in the above graph), representing 3.5% of the 3.25 million tonnes used across global agriculture. However, consumption is highly concentrated geographically. Brazil alone uses 60,568 tonnes, accounting for approximately 53% of global cotton pesticide consumption, followed by the United States (14,125 tonnes), China (10,081 tonnes) and India (7,769 tonnes). Together, these four countries account for approximately 81% of global cotton pesticide use. Australia (3,773 tonnes) and Pakistan (3,654 tonnes) are other significant consumers.

INPUT COST OF SEEDS & FERTILIZERS (US$ per hectare)

Fig-20. Seed Cost (US$ per hectare)

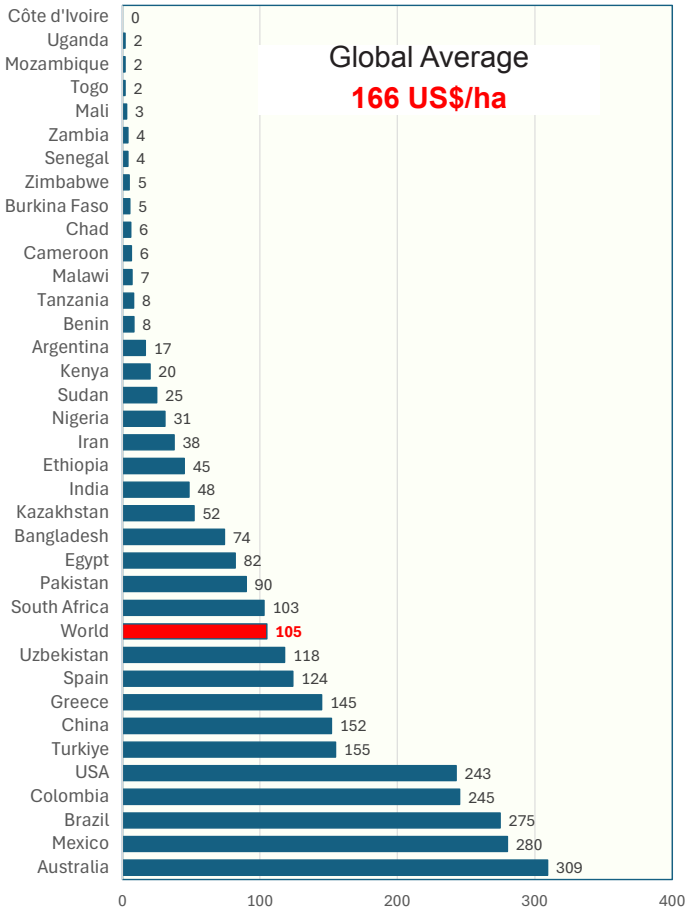
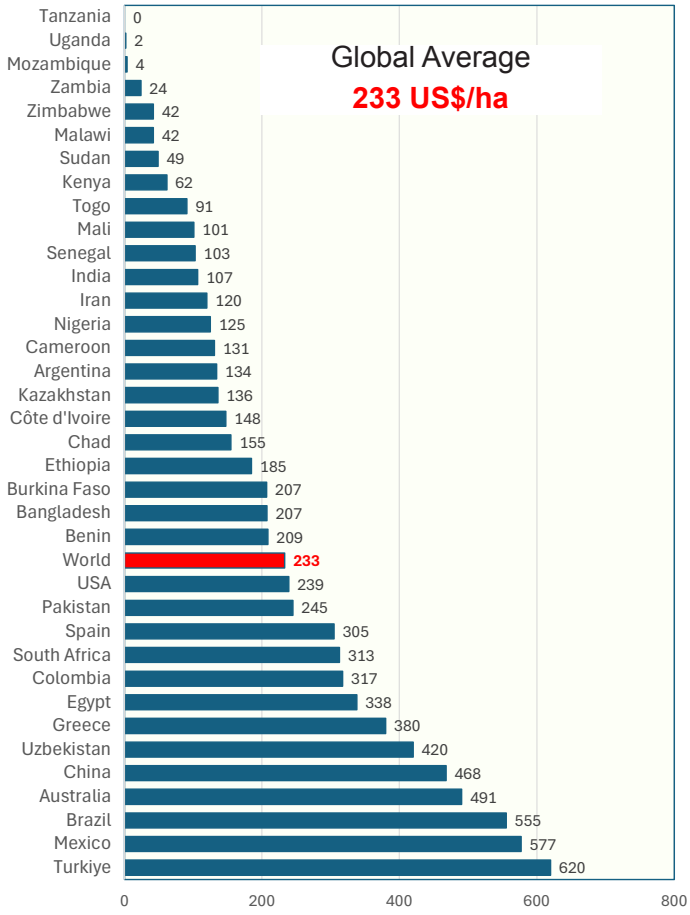


Fig-21. Fertilizer Cost (US$ per hectare)



Seed Cost (US$/ha):

Cotton seed costs vary enormously across producing countries, with a global average of US$105 per hectare. Australia records the highest expenditure at US$309/ha, followed by Mexico (US$280), Brazil (US$275), Colombia (US$245) and the United States (US$243). China (US$152) and Türkiye (US$155) also incur relatively high costs.

In contrast, seed expenditure is substantially lower across Asia and Africa. India spends US$48/ha, Pakistan US$90/ha and Bangladesh US$74/ha, while most African countries report costs below US$10/ha. Côte d'Ivoire records zero seed expenditure, potentially reflecting subsidised or institutionally supplied planting material.

These striking differences reflect variations in seed prices primarily reflected in the IPR royalties related with the GM seeds in Australia, USA, Mexico, Brazil and Colombia. High costs could also be related to seeding rates, proprietary hybrids, biotechnology traits, seed treatment and subsidy arrangements. Importantly, higher seed expenditure does not necessarily guarantee higher productivity. The challenge lies in ensuring farmers have affordable access to high-quality, locally adapted varieties that combine yield potential, pest resistance and climate resilience.

Fertilizer Cost (US$/ha):

Fertilizer expenditure reveals a striking divide between intensive cotton production systems and low-input smallholder agriculture.

Against a global average of US$233 per hectare, Türkiye records the highest expenditure at US$620/ha, followed by Mexico (US$577), Brazil (US$555), Australia (US$491) and China (US$468). Uzbekistan (US$420) and Egypt (US$338) also incur substantial fertilizer costs. India spends US$107/ha, less than half the global average, while Pakistan (US$245) and the United States (US$239) remain close to it. At the other extreme, Tanzania reports zero expenditure, followed by Uganda (US$2) and Mozambique (US$4), indicating extremely limited fertilizer investment.

Such disparities reflect differences in nutrient application rates, fertilizer prices, soil fertility, irrigation, subsidies and farmers' purchasing capacity. While inadequate fertilization can constrain yields and accelerate soil nutrient depletion, excessive expenditure may undermine profitability. Improving nutrient-use efficiency through soil testing, balanced fertilization, organic amendments and site-specific recommendations is essential for economically viable and environmentally sustainable cotton production.

INPUT COST OF HERBICIDES & INSECTICIDES (US$ per hectare)

Fig-22. Herbicides Cost (US$ per hectare)

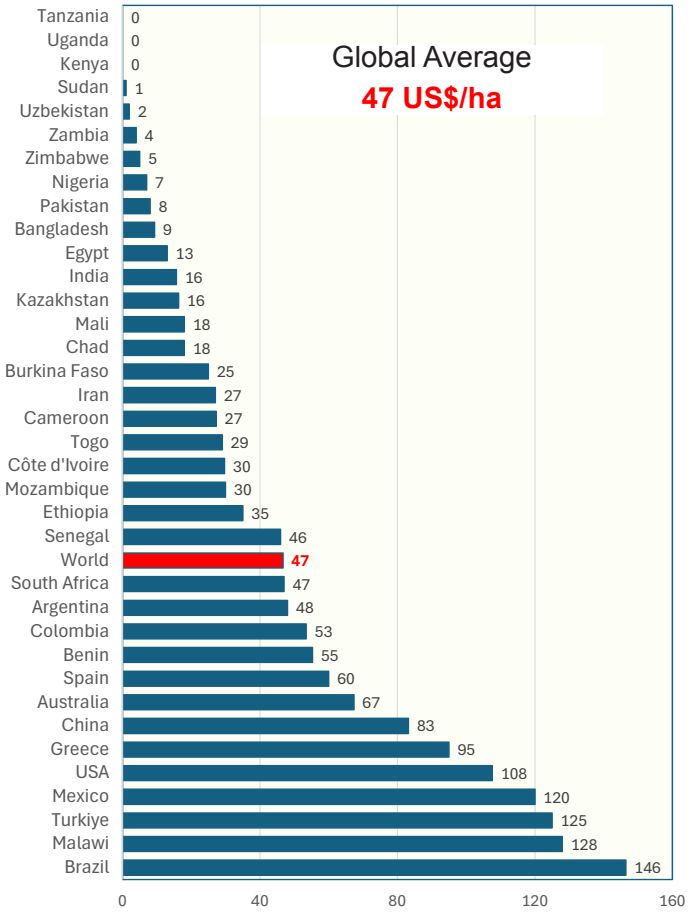
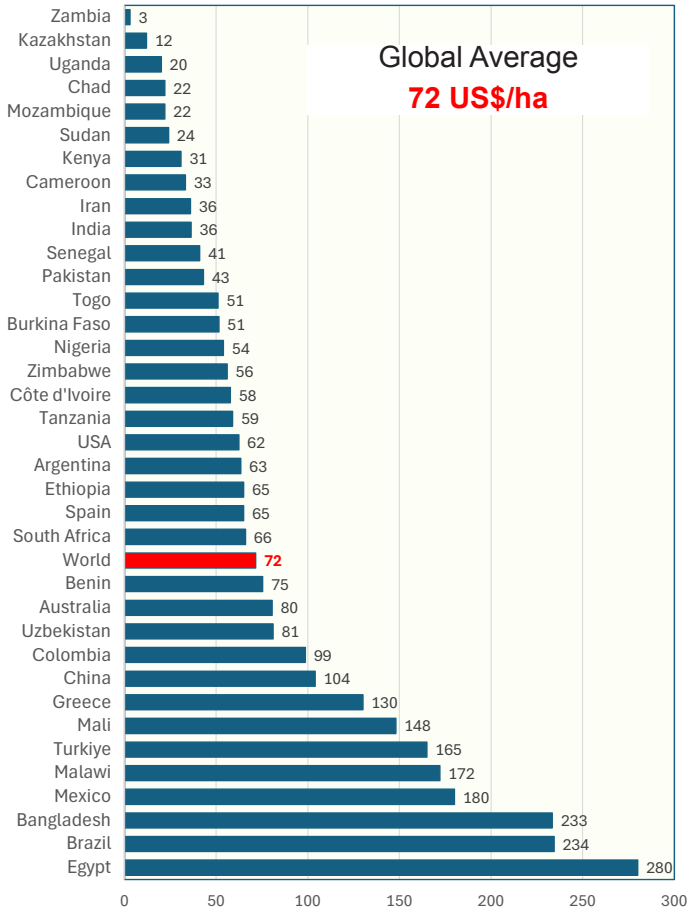


Fig-23. Insecticides Cost (US$ per hectare)



Herbicide Cost (US$/ha):

Herbicide expenditure in cotton cultivation varies considerably across countries, with a global average of US$47 per hectare.

Brazil records the highest expenditure at US$146/ha, more than three times the global average, followed by Malawi (US$128), Türkiye (US$125), Mexico (US$120) and the United States (US$108). China (US$83) and Australia (US$67) also report relatively high costs. In contrast, India spends only US$16/ha, while Pakistan (US$8), Uzbekistan (US$2) and several African countries incur minimal expenditure. Interestingly, Malawi's high herbicide expenditure contrasts sharply with the generally low chemical input costs across sub-Saharan Africa.

These differences reflect variations in herbicide application intensity, product prices, weed pressure, labour availability and weed management practices. Low herbicide expenditure does not necessarily imply lower weed management costs, as manual weeding can require substantial labour. Affordable mechanical weeders, integrated weed management and judicious herbicide use could help reduce production costs while limiting herbicide resistance and environmental risks.

Insecticide Cost (US$/ha):

Insecticide expenditure reveals striking differences in pest management costs across cotton-producing countries, against a global average of US$72 per hectare.

Egypt records the highest expenditure at US$280/ha, nearly four times the global average, followed by Brazil (US$234), Bangladesh (US$233), Mexico (US$180), Malawi (US$172) and Türkiye (US$165). Mali (US$148) and Greece (US$130) also report substantial expenditure. In contrast, India spends only US$36/ha, half the global average, while the United States (US$62) and Australia (US$80) remain relatively close to it. Zambia records the lowest expenditure at US$3/ha, followed by Kazakhstan (US$12) and Uganda (US$20).

Insecticide expenditure is shaped by a complex interplay of pest pressure, resistance development, pesticide prices and crop protection strategies. However, spending more on insecticides is no assurance of healthier crops or higher yields. The real opportunity lies in shifting from routine chemical applications to knowledge-intensive pest management, where timely surveillance, economic thresholds, biological control and resistance management help farmers achieve effective pest suppression at lower costs.

COST OF IRRIGATION & MACHINERY (US$ per hectare)

Fig-24. Irrigation Cost (US$ per hectare)

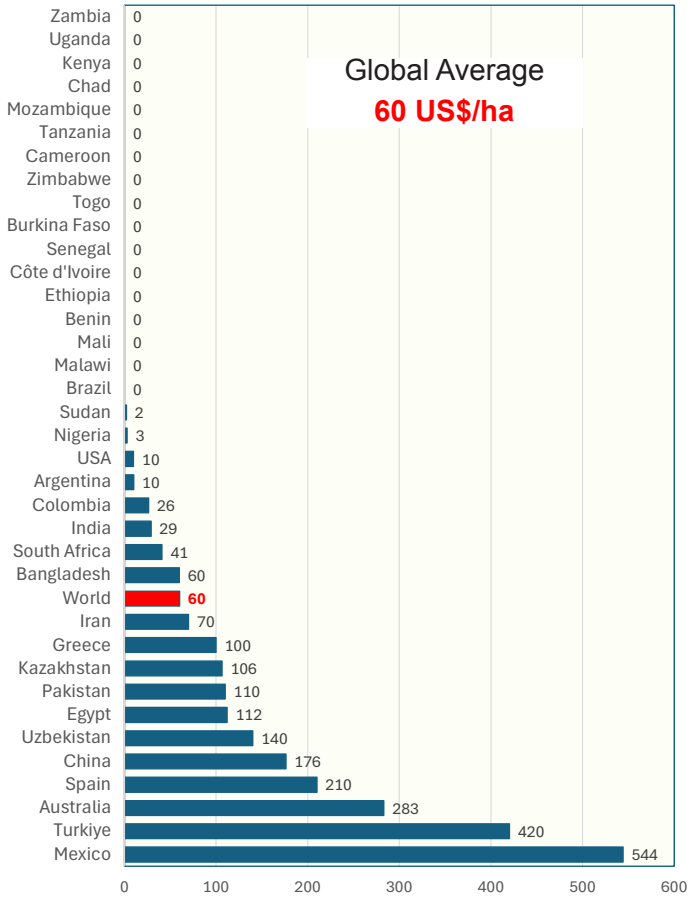
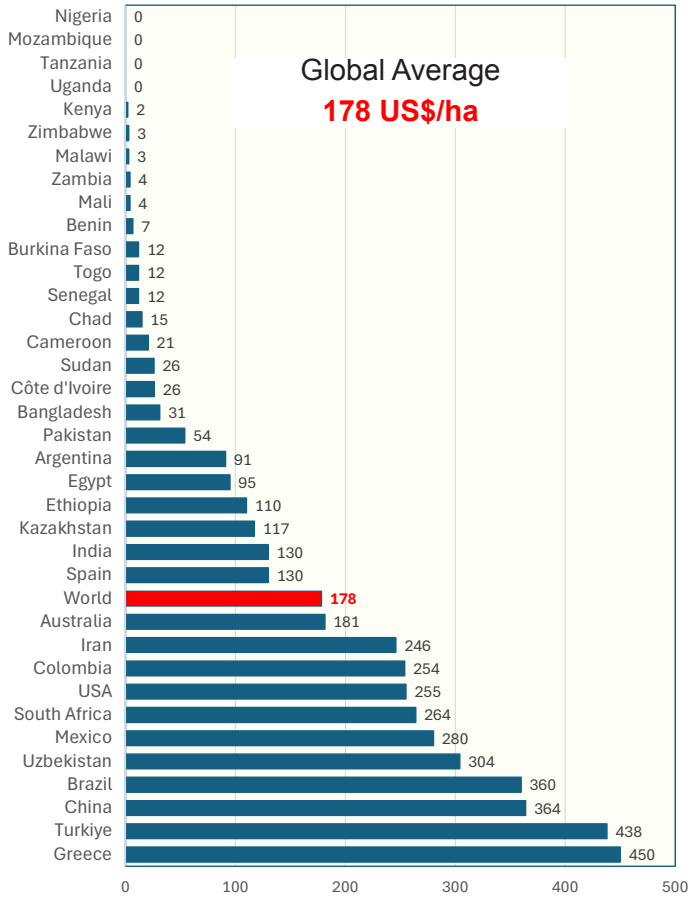


Fig-25. Machinery Cost (US$ per hectare)



Irrigation Cost (US$/ha):

Irrigation expenditure in cotton production reveals enormous differences across countries, with a global average of US$60 per hectare.

Mexico records the highest expenditure at US$544/ha, nine times the global average, followed by Türkiye (US$420), Australia (US$283), Spain (US$210) and China (US$176). Uzbekistan (US$140), Egypt (US$112) and Pakistan (US$110) also incur substantial irrigation costs. In contrast, India spends just US$29/ha, reflecting its large proportion of rainfed cotton cultivation. Most African cotton-producing countries report virtually no irrigation expenditure, highlighting their overwhelming dependence on seasonal rainfall. Interestingly, Brazil reports zero irrigation costs, consistent with its predominantly rainfed commercial cotton production. These differences illustrate how access to water, irrigation infrastructure, energy prices and climatic conditions shape production economics. High irrigation expenditure can support greater yield stability but also increases production costs and exposure to water scarcity. Improving water productivity through efficient irrigation (drip and sprinklers), rainwater harvesting and soil moisture conservation will be increasingly important as climate variability intensifies.

Machinery Usage Cost (US$/ha):

Machinery expenditure provides a revealing perspective on the technological divide in global cotton farming. Against a global average of US$178 per hectare, Greece records the highest expenditure at US$450/ha, followed by Türkiye (US$438), China (US$364), Brazil (US$360) and Uzbekistan (US$304). Mexico (US$280), South Africa (US$264) and the United States (US$255) also report substantial machinery costs. Australia spends US$181/ha, close to the global average, while India records US$130/ha, reflecting partial mechanisation alongside continued dependence on manual labour. In stark contrast, machinery expenditure is negligible across much of sub-Saharan Africa, with Nigeria, Mozambique, Tanzania and Uganda reporting zero expenditure. These differences reflect contrasting farm sizes, mechanisation levels, machinery ownership, hiring arrangements and operational costs. Interestingly, higher machinery expenditure does not necessarily imply greater economic efficiency, as costs depend on utilisation rates and scale. For smallholder cotton systems, affordable machinery, custom-hiring centres and cooperative mechanisation services could reduce labour dependence, improve timeliness of operations and enhance profitability.

COST OF WEEDING & HARVESTING (US$ per hectare)

Fig-26. Weeding Cost (US$ per hectare)

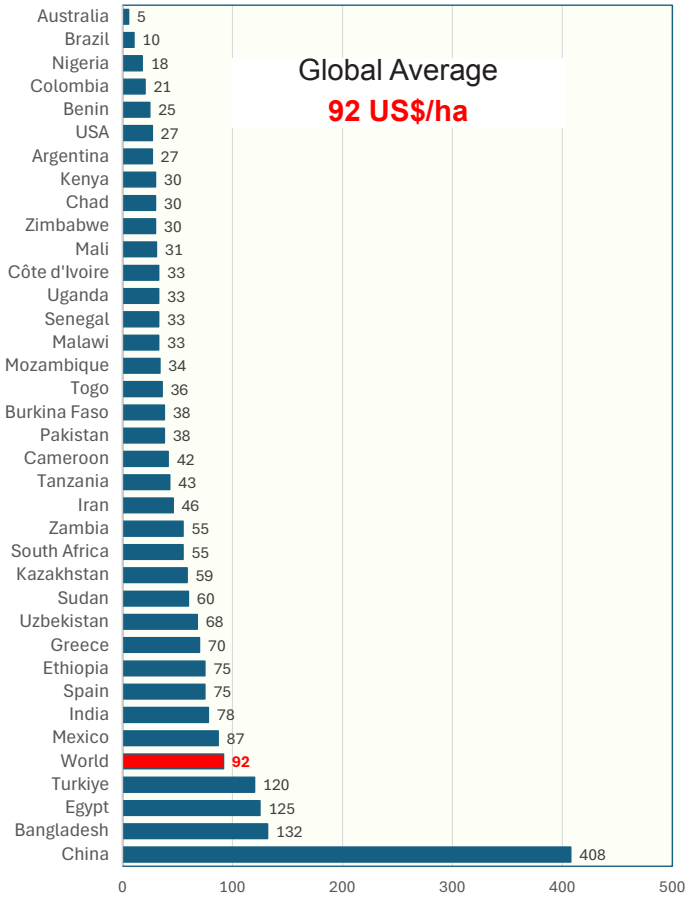
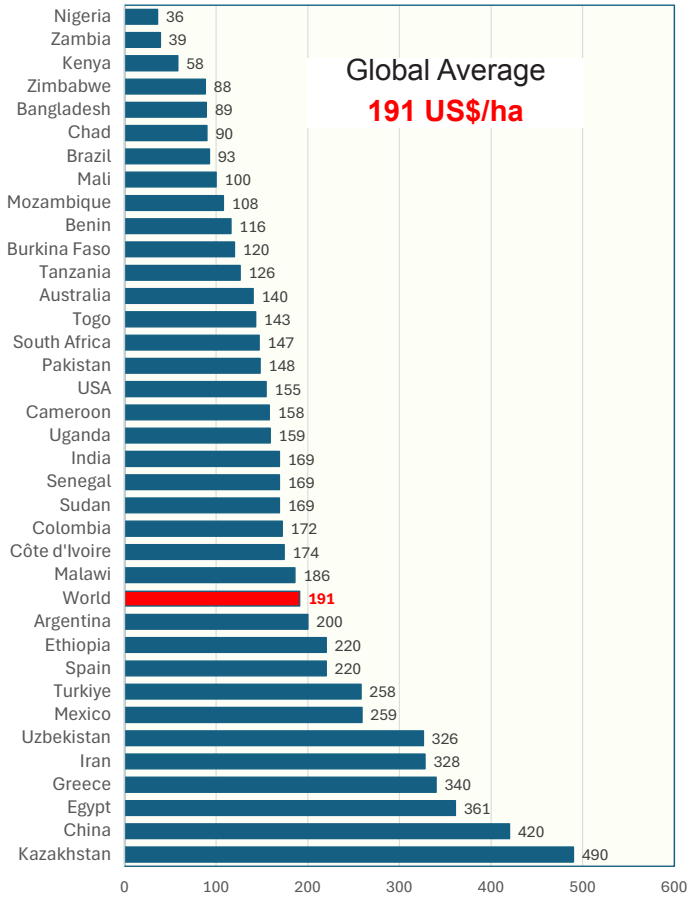


Fig-27. Harvesting Cost (US$ per hectare)



Weeding Cost (US$/ha):

Weeding costs present an interesting paradox in global cotton production, with a world average of US$92 per hectare.

China stands out with an exceptionally high expenditure of US$408/ha, more than four times the global average, followed by Bangladesh (US$132), Egypt (US$125) and Türkiye (US$120). India spends US$78/ha, reflecting its considerable dependence on manual weeding, while Pakistan records US$38/ha.

Surprisingly, highly mechanised cotton economies such as Australia (US$5), Brazil (US$10) and the United States (US$27) report some of the lowest weeding costs. Most African countries also record relatively modest expenditure, generally between US$18 and US$43/ha, despite substantial reliance on manual labour.

These differences in weeding costs suggest that weeding expenditure depends not merely on labour intensity but also on wage rates, weed pressure and management practices. For smallholder farmers, timely weed control through affordable mechanical weeders, appropriate herbicides and improved agronomic practices could substantially reduce production costs and labour requirements.

Harvesting Cost (US$/ha):

Harvesting is among the most economically significant operations in cotton cultivation, with a global average expenditure of US$191 per hectare.

Kazakhstan records the highest harvesting cost at US$490/ha, followed by China (US$420), Egypt (US$361), Greece (US$340), Iran (US$328) and Uzbekistan (US$326). Türkiye (US$258) and Mexico (US$259) also incur substantial expenditure. India spends US$169/ha, despite its exceptionally high dependence on manual picking, while Bangladesh records just US$89/ha.

Interestingly, highly mechanised countries such as Brazil (US$93), Australia (US$140) and the United States (US$155) maintain harvesting costs below the global average. Across Africa, costs range from US$36/ha in Nigeria to US$220/ha in Ethiopia.

These differences highlight the influence of wage rates, harvesting methods, machinery costs, cotton yields and operational efficiency. Importantly, harvesting costs per hectare must be interpreted alongside lint yields, as cost per kilogram of harvested cotton provides a more meaningful measure of harvesting efficiency and competitiveness.

COST OF GINNING & LABOUR EMPLOYED (US$ per hectare)

Fig-28. Ginning Cost (US$ per hectare)

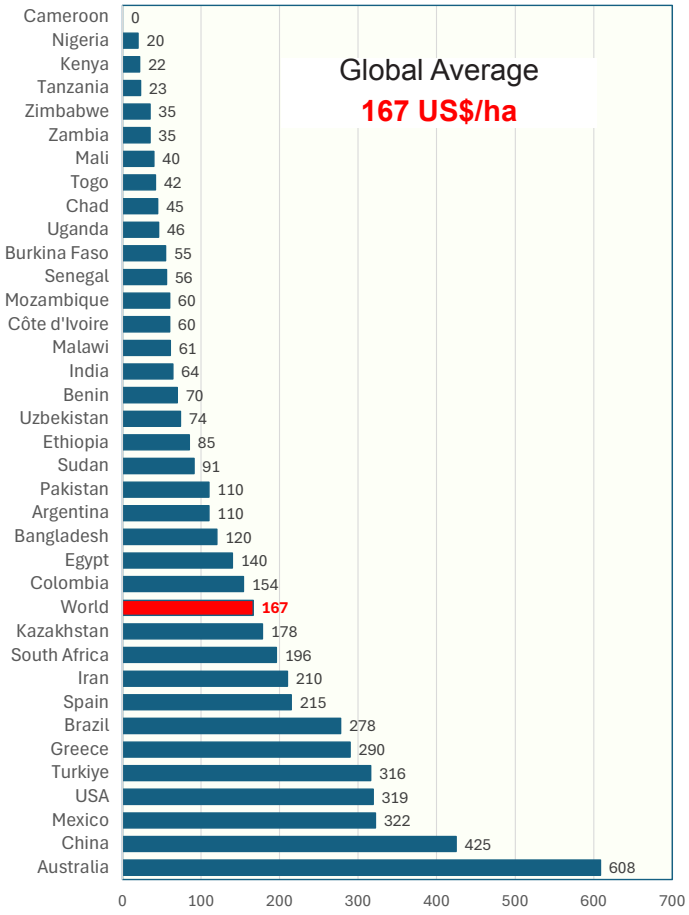
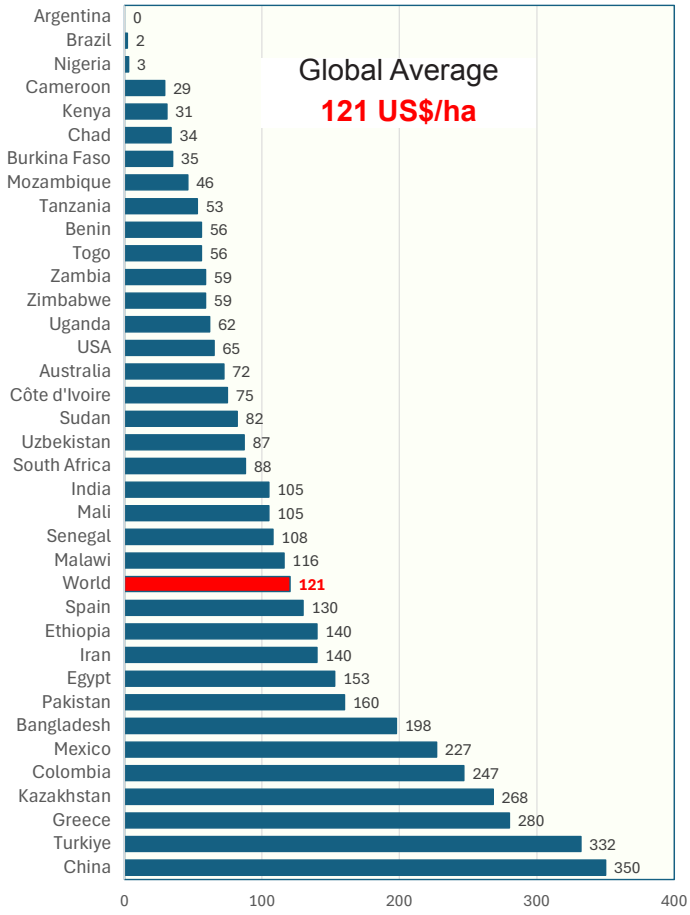


Fig-29. Labour Cost (US$ per hectare)



Ginning Cost (US$/ha):

Ginning costs reveal substantial differences in the economics of cotton processing, with a global average of US$167 per hectare.

Australia tops the chart at US$608/ha, nearly four times the global average, followed by China (US$425), Mexico (US$322), the United States (US$319) and Türkiye (US$316). Brazil (US$278) and Greece (US$290) also record considerable expenditure.

At the other end, ginning costs are remarkably low across much of Africa, ranging from US$20/ha in Nigeria to US$70/ha in Benin, while Cameroon reports zero. India spends US$64/ha, substantially below the global average, whereas Pakistan records US$110/ha.

The differences are influenced by cotton yields, ginning technologies, energy prices, labour costs and processing efficiency. Since ginning costs are expressed per hectare, higher expenditure may simply reflect larger quantities of seed cotton processed rather than inefficiency.

A comparison of ginning costs per kilogram of lint would provide a clearer picture of processing efficiency and international competitiveness.

Labour Cost (US$/ha):

Labour expenditure tells a fascinating story of how cotton production systems differ across the world.

Against a global average of US$121 per hectare, China records the highest labour cost at US$350/ha, followed by Türkiye (US$332), Greece (US$280), Kazakhstan (US$268) and Colombia (US$247). Bangladesh (US$198) and Pakistan (US$160) also incur substantial expenditure, while India spends US$105/ha, despite its exceptionally high labour requirement of 329 man-days per hectare.

In sharp contrast, Brazil (US$2), Argentina (US$0) and the United States (US$65) demonstrate the economic implications of extensive mechanisation.

Across Africa, labour costs generally remain low, although Ethiopia (US$140) and Malawi (US$116) are notable exceptions. These figures illustrate an important distinction: labour intensity and labour expenditure are not necessarily proportional, particularly where family labour is unpaid or wages are low. As rural wages rise and agricultural labour becomes increasingly scarce, the economic case for affordable, smallholder-compatible mechanisation will become difficult to ignore.

COST OF CULTIVATION & NET RETURNS (US$ per hectare)

Fig-30. Total Cost of Cultivation (US$ per hectare)

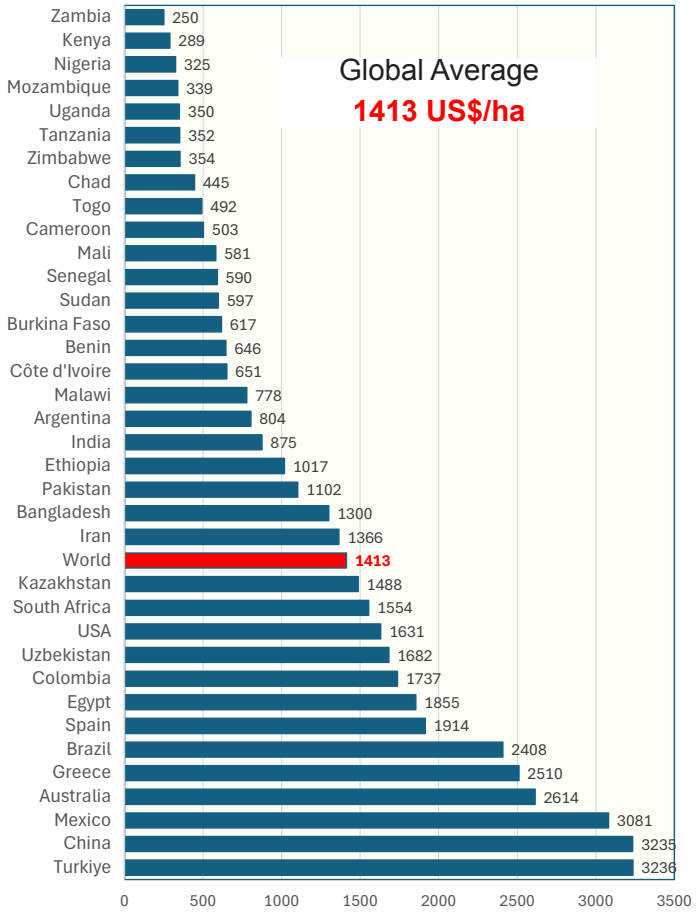
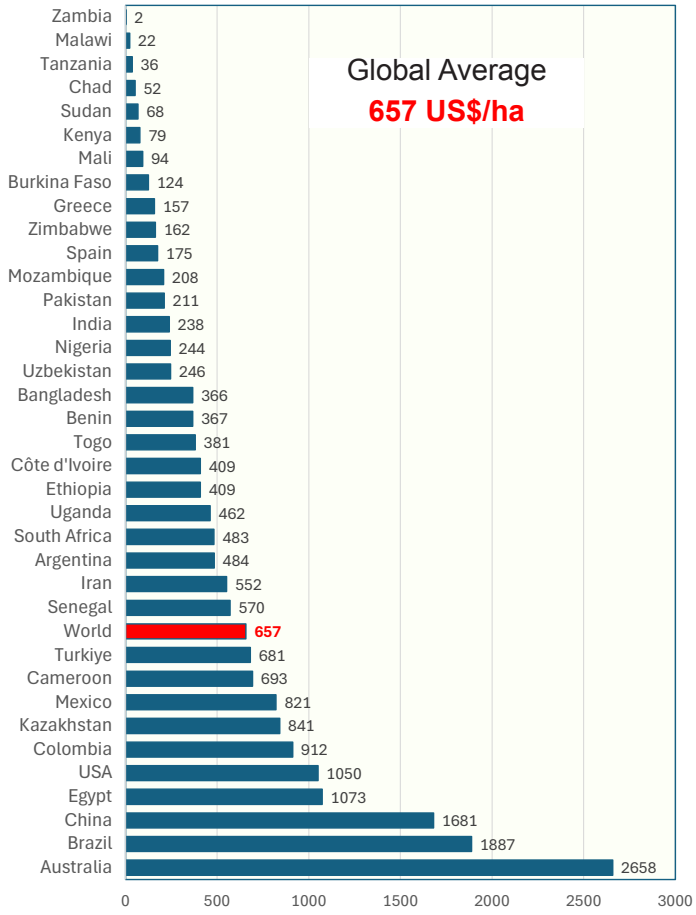


Fig-31. Net Returns (US$ per hectare)



Total Cost of Cotton Cultivation (US$/ha):

The total cost of cotton cultivation varies enormously across countries, with a global average of US$1,413 per hectare. Türkiye (US$3,236) and China (US$3,235) record the highest production costs, followed by Mexico (US$3,081), Australia (US$2,614), Greece (US$2,510) and Brazil (US$2,408). The United States spends US$1,631/ha, while India (US$875) and Pakistan (US$1,102) operate considerably below the global average. Across sub-Saharan Africa, cultivation costs are substantially lower, ranging from US$250/ha in Zambia to US$778/ha in Malawi, reflecting predominantly low-input, labour-intensive production systems. However, low cultivation costs should not be mistaken for economic efficiency, as they frequently accompany low productivity, limited mechanisation and inadequate investment in crop nutrition. Equally, high expenditure may be economically justified where superior yields generate proportionately greater revenues. The real measure of competitiveness, therefore, is not expenditure per hectare but production cost per kilogram of lint, considered alongside yield stability and profitability. Ultimately, cotton farming rewards the efficiency with which resources are converted into marketable fibre, rather than the amount spent cultivating the crop.

Net Returns (US$/ha):

The global average net return from cotton cultivation is estimated at US$657 per hectare, but profitability differs dramatically across producing countries. Australia leads with an impressive US$2,658/ha, more than four times the global average, followed by Brazil (US$1,887), China (US$1,681), Egypt (US$1,073) and the United States (US$1,050). Colombia (US$912) and Kazakhstan (US$841) also achieve substantial returns. In contrast, India records US$238/ha, Pakistan US$211/ha and Uzbekistan US$246/ha, despite cotton's considerable economic importance in these countries. The situation is particularly concerning in parts of Africa, where Zambia earns just US$2/ha, Malawi US$22/ha and Tanzania US$36/ha. Interestingly, Türkiye, despite having the highest cultivation cost, generates net returns of US$681/ha, only marginally above the global average. Meanwhile, Australia demonstrates that relatively high production expenditure can coexist with exceptional profitability. These figures expose a fundamental reality of global cotton economics: low investment does not guarantee profitability, nor does high investment necessarily undermine it. What ultimately matters is the combined influence of productivity, input-use efficiency, market prices and the value realised from each hectare.

COST OF PRODUCTION (US$ per Kg seed-cotton and lint)

Fig-32. Production Cost (US$ per kg seed-cotton)

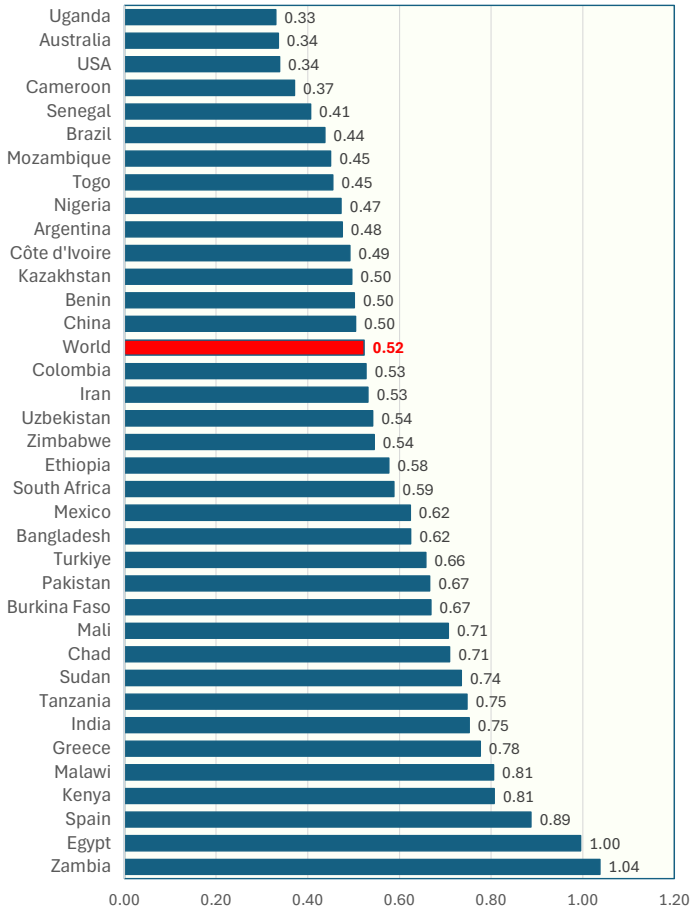
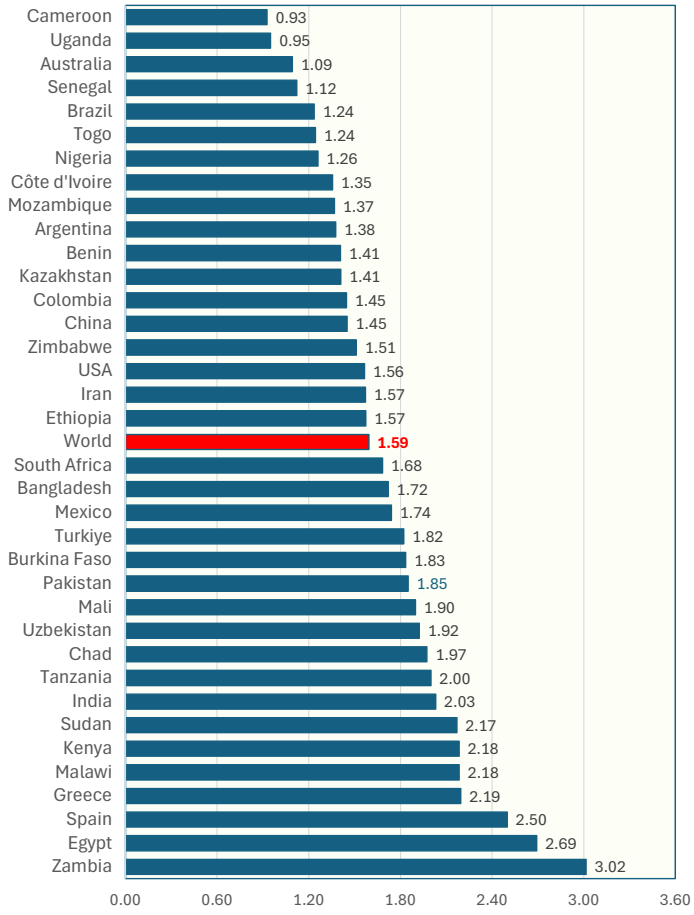


Fig-33. Production Cost (US$ per kg lint)



Cost of Producing Seed-Cotton (US$/Kg):

The global average cost of producing seed cotton is US$0.52 per kilogram, but production economics vary considerably across cotton-growing countries.

Uganda records the lowest cost at US$0.33/kg, followed by Australia and the United States (US$0.34), Cameroon (US$0.37), Senegal (US$0.41) and Brazil (US$0.44). China (US$0.50) also operates slightly below the global average. At the opposite end, Zambia has the highest production cost at US$1.04/kg, followed by Egypt (US$1.00), Spain (US$0.89), Kenya and Malawi (US$0.81 each). India and Tanzania record US$0.75/kg, approximately 44% above the global average, while Pakistan stands at US$0.67/kg.

Interestingly, Australia and the United States achieve low unit costs despite relatively high cultivation expenditure per hectare, illustrating the economic advantages of high productivity and mechanisation. Conversely, low-input farming does not necessarily ensure inexpensive cotton when yields remain poor.

The figures demonstrate how productivity, input efficiency and economies of scale ultimately determine the cost competitiveness of seed cotton in international markets.

Cost of Producing Lint (US$/Kg):

When production costs are expressed per kilogram of lint, the economic divide between cotton-producing countries becomes particularly revealing.

The global average lint production cost is US$1.59/kg, with Cameroon recording the lowest cost at US$0.93/kg, followed by Uganda (US$0.95), Australia (US$1.09) and Senegal (US$1.12). Brazil and Togo achieve US$1.24/kg, while China and Colombia record US$1.45/kg. The United States, at US$1.56/kg, remains close to the global average. In contrast, Zambia faces the highest production cost at US$3.02/kg, followed by Egypt (US$2.69), Spain (US$2.50), Greece (US$2.19) and Kenya and Malawi (US$2.18 each). India records US$2.03/kg, approximately 28% above the global average, while Pakistan (US$1.85) and Uzbekistan (US$1.92) also face relatively high costs. Unlike expenditure per hectare, lint production cost captures the combined influence of crop productivity, cultivation expenditure and ginning recovery.

This distinction is crucial: countries producing inexpensive lint are better positioned to withstand international price fluctuations, whereas high-cost producers face narrower profit margins and greater market vulnerability.

% SHARE OF SEED COST & FERTILIZER COST

Fig-34. Seed Cost (% of total cost)

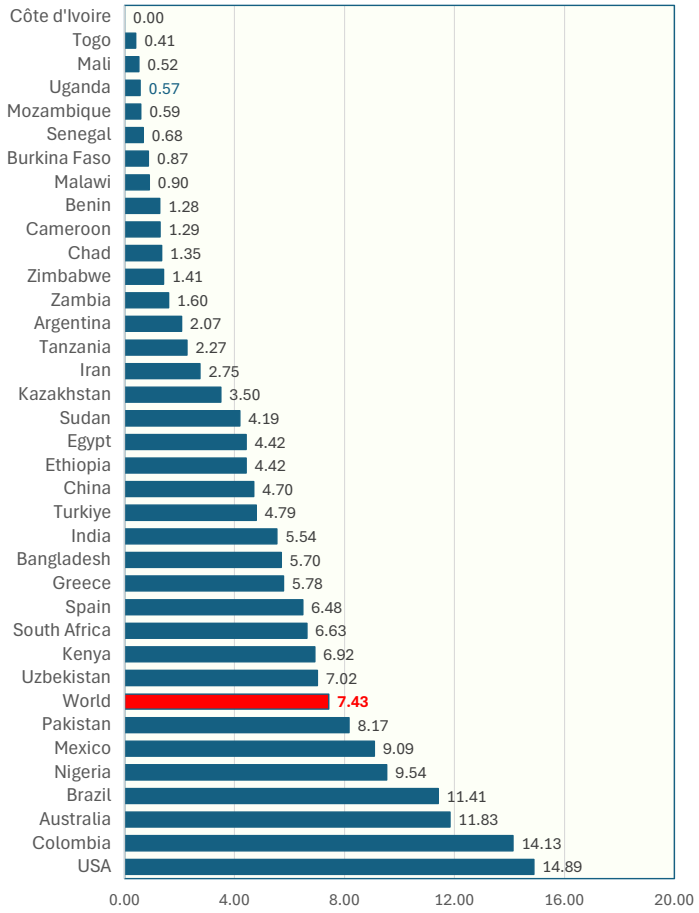
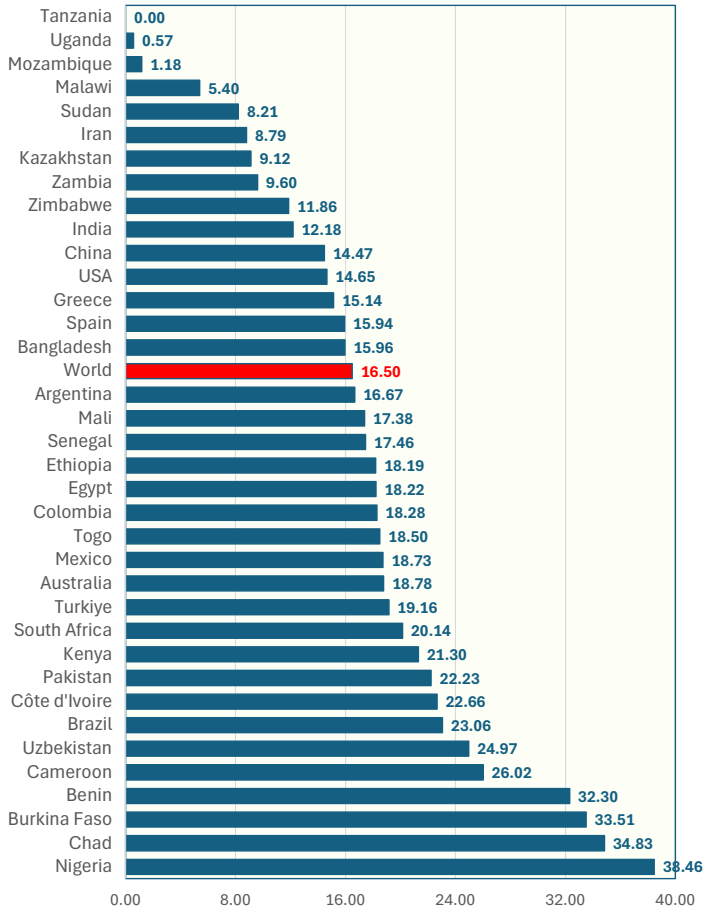


Fig-35. Fertilizer Cost (% of total cost)



Share of Seed Cost as % of Total Cost:

Seed expenditure accounts for 7.43% of the total cost of cotton cultivation globally, but its relative importance differs considerably across production systems.

The United States records the highest share at 14.89%, followed by Colombia (14.13%), Australia (11.83%) and Brazil (11.41%). Mexico (9.09%) and Pakistan (8.17%) also exceed the global average. In contrast, India allocates 5.54% of cultivation expenditure to seed, while China (4.70%) and Türkiye (4.79%) report slightly lower proportions. Across much of sub-Saharan Africa, seed costs account for less than 2%, with Côte d'Ivoire recording zero and Togo just 0.41%.

These exceptionally low shares may reflect subsidised seed distribution, low seed prices or limited expenditure on improved planting material. Interestingly, higher seed-cost shares are not necessarily associated with higher productivity, since seed quality, varietal suitability and crop management jointly influence yield outcomes.

The figures raise an important question for cotton development: are farmers investing sufficiently in genetic improvement, or are high seed prices consuming resources without delivering commensurate productivity gains?

Share of Fertilizer Cost as % of Total Cost:

Fertilizers account for 16.50% of total cotton cultivation costs globally, making crop nutrition a major component of production expenditure.

Nigeria records the highest proportion at 38.46%, followed by Chad (34.83%), Burkina Faso (33.51%) and Benin (32.30%). Cameroon (26.02%) and Uzbekistan (24.97%) also devote substantial shares of their cultivation budgets to fertilizers.

Interestingly, several African countries report high fertilizer-cost proportions despite relatively modest absolute expenditure, illustrating how expensive fertilizers can become within low-cost farming systems. Brazil (23.06%) and Pakistan (22.23%) exceed the global average, while Australia (18.78%) and Türkiye (19.16%) remain moderately above it. India allocates 12.18%, compared with China (14.47%) and the United States (14.65%).

At the opposite extreme, Tanzania reports zero fertilizer expenditure, while Uganda (0.57%) and Mozambique (1.18%) invest very little.

The central concern is not simply how much farmers spend on fertilizers, but whether each dollar invested generates sufficient additional yield to justify its cost.

% SHARE OF INSECTICIDE COST & HARVEST COST

Fig-36. Insecticide Cost (% of total cost)

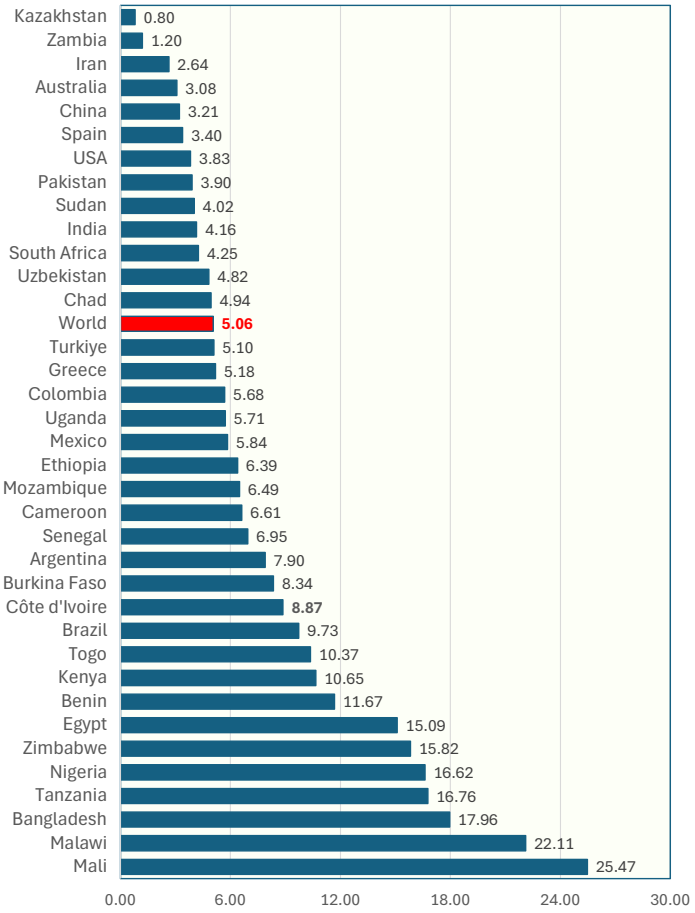
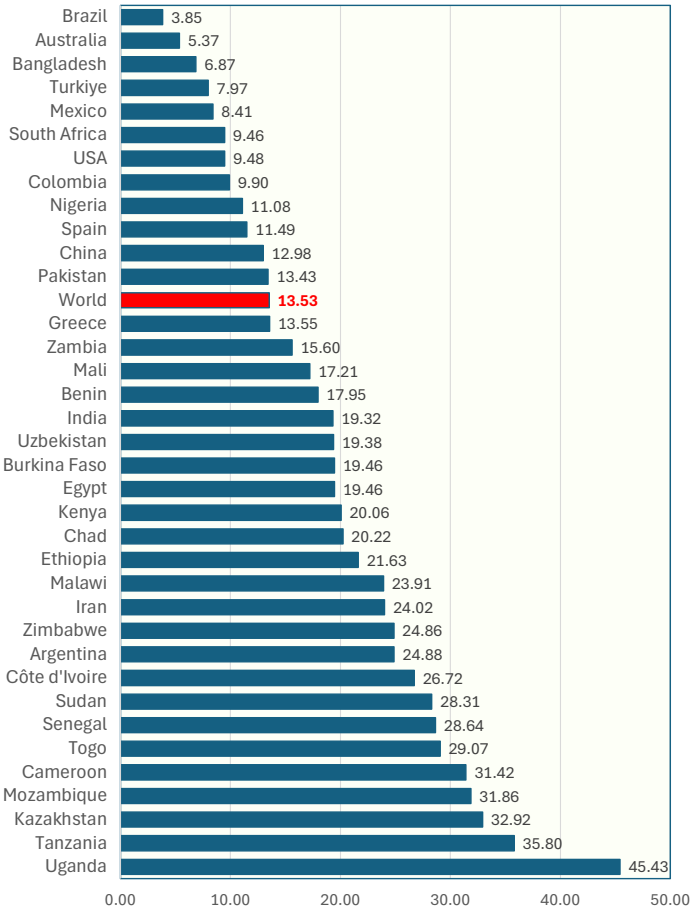


Fig-37. Harvest Cost (% of total cost)



Share of Insecticide Cost as % of Total Cost:

Insecticides account for 5.06% of total cotton cultivation costs globally, but their financial burden varies dramatically across production systems.

Mali records the highest share at 25.47%, followed by Malawi (22.11%), Bangladesh (17.96%), Tanzania (16.76%) and Nigeria (16.62%). Egypt (15.09%) and Zimbabwe (15.82%) also devote substantial portions of their cultivation budgets to insecticides. Interestingly, Brazil, despite its exceptionally high insecticide expenditure of US$234/ha, allocates only 9.73% of total costs to insecticides. In contrast, India (4.16%), China (3.21%), Australia (3.08%) and the United States (3.83%) remain below the global average. Kazakhstan records the lowest proportion at just 0.80%.

The particularly high shares across several African countries suggest that insecticide purchases can impose a disproportionate financial burden on smallholder farmers operating with limited resources. More importantly, repeated spraying can erode already narrow profit margins, especially when pest resistance reduces treatment effectiveness. For these farmers, preventing avoidable insecticide expenditure may be just as valuable as increasing cotton yields.

Share of Harvesting Cost as % of Total Cost:

Harvesting absorbs 13.53% of total cotton cultivation expenditure globally, although its share ranges from just 3.85% in Brazil to an extraordinary 45.43% in Uganda. Tanzania follows at 35.80%, while Kazakhstan (32.92%), Mozambique (31.86%) and Cameroon (31.42%) also devote nearly one-third of their cultivation budgets to harvesting. Senegal (28.64%), Sudan (28.31%) and Togo (29.07%) illustrate the considerable economic importance of cotton picking in smallholder systems. India allocates 19.32%, substantially above the global average, reflecting its continued dependence on manual harvesting. In contrast, highly mechanised cotton economies such as Australia (5.37%), Türkiye (7.97%), Mexico (8.41%) and the United States (9.48%) maintain relatively low harvesting-cost shares. Interestingly, Bangladesh records only 6.87%, despite its predominantly manual harvesting practices, illustrating the influence of wage rates and overall production costs. The contrast is particularly revealing: where harvesting consumes nearly half the cultivation budget, even modest improvements in picking efficiency could significantly influence farm profitability. However, mechanisation must be economically appropriate to farm size, harvesting conditions and machinery utilisation.

EFFECTIVE RAINFALL (MM) & CONSUMPTIVE BLUE WATER FOOTPRINT (L/kg lint)

Fig-38. Effective Rainfall (mm)

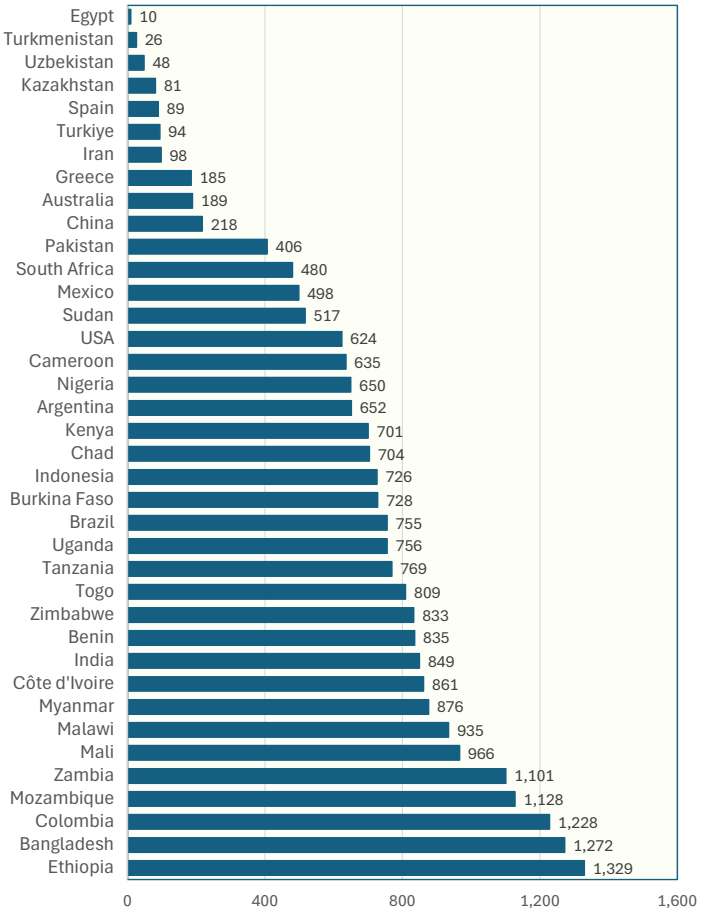
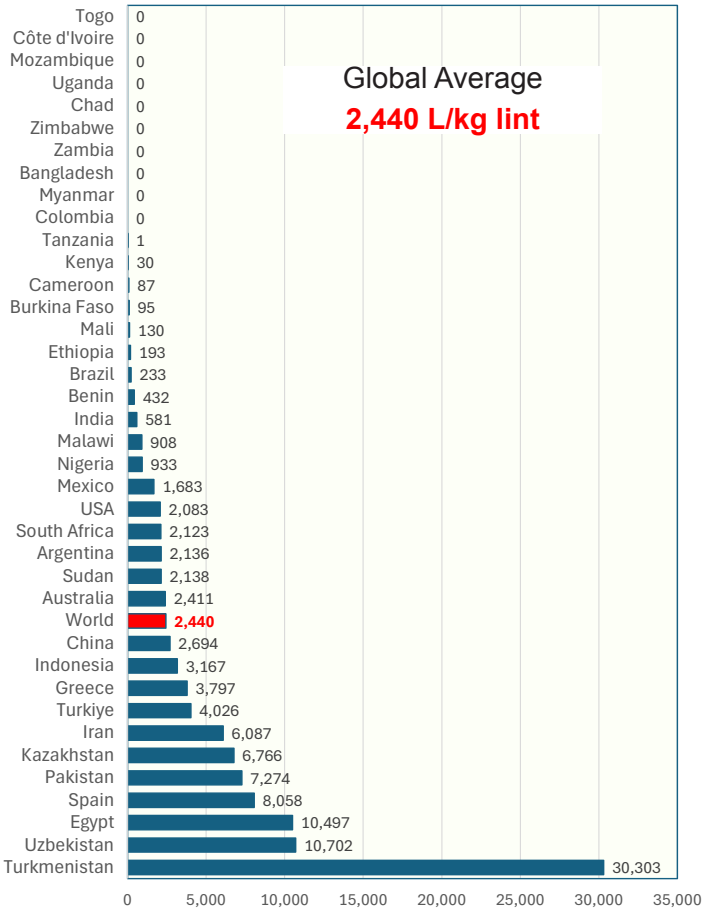


Fig-39. Consumptive Irrigation Footprint (L/kg lint)



Effective Rainfall in the Cotton Season (mm):

Effective rainfall during the cotton-growing season varies enormously across countries, illustrating the contrasting climatic environments in which cotton is cultivated. Ethiopia receives the highest effective rainfall at 1,329 mm, followed by Bangladesh (1,272 mm), Colombia (1,228 mm), Mozambique (1,128 mm) and Zambia (1,101 mm). India receives 849 mm, while Brazil (755 mm), Tanzania (769 mm) and Uganda (756 mm) benefit from substantial seasonal rainfall. At the opposite extreme, Egypt receives only 10 mm, followed by Turkmenistan (26 mm), Uzbekistan (48 mm), Kazakhstan (81 mm) and Spain (89 mm), explaining their heavy dependence on irrigation. Australia (189 mm), China (218 mm) and Türkiye (94 mm) also receive relatively limited effective rainfall. Interestingly, abundant rainfall does not automatically ensure high cotton productivity, as its distribution, timing and intensity are often more important than seasonal totals.

Excessive rainfall can also cause waterlogging, nutrient losses and harvesting difficulties. The challenge for rainfed cotton systems is therefore not merely receiving sufficient rainfall, but conserving soil moisture and ensuring water availability during critical flowering and boll-development stages.

Consumptive Irrigation Footprint (L/kg lint):

The consumptive irrigation water footprint of cotton averages 2,440 litres per kilogram of lint globally, revealing extraordinary differences in dependence on irrigation water. Turkmenistan stands out at 30,303 L/kg, more than twelve times the global average, followed by Uzbekistan (10,702), Egypt (10,497), Spain (8,058) and Pakistan (7,274). Kazakhstan (6,766) and Iran (6,087) also record exceptionally high values, reflecting cotton cultivation under water-scarce conditions and substantial irrigation requirements relative to lint production. In contrast, Australia (2,411), the United States (2,083) and Brazil (233) have considerably smaller footprints, while India records just 581 L/kg, reflecting its predominantly rainfed cotton cultivation.

Several African countries report negligible irrigation footprints because cotton is grown almost entirely with rainfall. These figures expose a critical distinction between irrigation dependence and overall water consumption: a low irrigation footprint does not necessarily imply low total crop water use. In water-stressed regions, the sustainability of cotton increasingly depends on improving irrigation efficiency, water productivity and the allocation of scarce freshwater resources.

DISCUSSION

Area and productivity

Cotton cultivation is geographically concentrated. India (11.48 million ha), the United States (3.17 million ha), China (2.98 million ha), Brazil (2.04 million ha) and Pakistan (2.01 million ha) together account for about 74% of the global cotton area of 29.4 million ha. Uzbekistan (0.88 million ha) follows. Argentina, Mali, Turkmenistan, Benin and Australia each cultivate 0.5–0.6 million ha, while several African countries maintain smaller, smallholder-based cotton sectors.

Productivity bears little relation to area. Global lint yield averages 866 kg/ha. Australia (2,391 kg/ha), China (2,229 kg/ha) and Brazil (1,948 kg/ha) lead, followed by Israel, Türkiye and Mexico, all above 1,750 kg/ha.

In contrast, India records only 431 kg/ha, and yields across sub-Saharan Africa are extremely low: Zambia 83 kg/ha, Kenya 132 kg/ha, Tanzania 176 kg/ha and Chad 225 kg/ha. Pakistan (596 kg/ha) and several Central Asian countries also fall below the global average.

The countries with the largest areas are therefore not necessarily the most productive. The resulting yield gaps represent a large untapped potential for raising global output without expanding cotton area.

Farm structure, labour and mechanisation

The global average cotton holding is only 1.4 ha, reflecting the predominance of smallholders. Farm size, however, ranges from 0.3 ha in Egypt, 0.4 ha in China and 1.1 ha in India to 189 ha in the United States, 254 ha in Argentina, 285 ha in Brazil and 319 ha in Australia. Farm size closely mirrors labour intensity.

Against a global average of 158 man-days/ha, the United States and Australia require only one man-day, China four and Brazil 15. India requires 329 man-days/ha, followed by Bangladesh (268), Egypt (192) and Malawi (192).



Fig-40. Deployment of labour in India



Fig-41. Machine picker in Uzbekistan

Weeding and picking account for most of this labour. India requires 96 man-days/ha for weeding, against a global average of 41, and 140 man-days/ha for picking, against a global average of 66. India's picking labour alone exceeds the total labour used for all operations in several countries. Globally, 51% of planting, 40% of weeding and 68% of picking are still done by hand. Planting and picking are entirely manual in India, Pakistan, Egypt and most African countries. In contrast, harvesting is fully mechanised in the United States, Australia, Brazil, Argentina, Spain and Greece, and largely mechanised in Mexico (99%), South Africa (97%), Türkiye (93%) and China (90%).

China is a notable case. Despite very small holdings, it has mechanised 90% of harvesting, which shows that small farm size is not an insurmountable barrier where machinery services, suitable varieties and institutional support are available. For other smallholder systems, the priorities are compact plant types with synchronised boll opening, effective defoliation, affordable small-scale weeders and seeders, and custom-hiring services.

Input use

Input intensity varies enormously. Nitrogen use averages 149 kg N/ha. It is highest in Egypt (375 kg/ha), China (328 kg/ha) and Turkmenistan (304 kg/ha), whereas Uganda (4 kg/ha), Senegal (5 kg/ha) and Tanzania (10 kg/ha) apply almost none. Total NPK use follows a similar pattern. China applies 684 kg/ha, 2.7 times the global average of 254 kg/ha, while the United States applies only 95 kg/ha yet achieves above-average yields. This shows that high productivity does not depend on excessive fertilizer use. Africa faces nutrient mining under low-input farming, while China and Egypt risk over-fertilization, nitrate leaching and nitrous oxide emissions.

Pesticide use averages 3.9 kg/ha. Brazil applies 29.7 kg/ha, nearly eight times the global average, and uses 60,568 t annually, about 53% of the 113,949 t used on cotton worldwide. Brazil, the United States, China and India together account for about 81% of cotton pesticide use. India uses



Fig-42. Pesticides

only 0.7 kg/ha, and its herbicide use (0.1 kg/ha) is negligible because weeds are controlled mainly by hand. These patterns point to integrated weed and pest management as the common route to balancing labour savings, resistance risk and environmental safety.

Cost of cultivation and cost structure

The total cost of cultivation averages US$1,413/ha. It is highest in Türkiye (US$3,236/ha), China (US$3,235/ha) and Mexico (US$3,081/ha), and lowest in sub-Saharan Africa (US$250–778/ha). India (US$875/ha) and Pakistan (US$1,102/ha) fall below the average. The composition of costs differs sharply between systems:

Seed costs are highest where genetically modified seed carries royalties: Australia (US$309/ha), Mexico (US$280/ha), Brazil (US$275/ha) and the United States (US$243/ha). Most African countries spend less than US$10/ha.

Fertilizers account for 16.5% of total costs globally but more than 30% in Nigeria, Chad, Burkina Faso and Benin, showing how expensive nutrients weigh on low-cost systems.

Insecticides account for 5.1% of costs globally but 25.5% in Mali and 22.1% in Malawi.

Harvesting accounts for 13.5% of costs globally, ranging from 3.9% in Brazil to 45.4% in Uganda. India allocates 19.3%.

Labour costs show that labour intensity and labour expenditure are not proportional. India spends only US$105/ha despite using 329 man-days/ha, because wages are low and family labour is often unpaid. China spends US$350/ha. As rural wages rise, the hidden cost of manual operations will become increasingly visible, strengthening the economic case for mechanisation.

Profitability and unit costs

Net returns average US$657/ha. Australia (US$2,658/ha), Brazil (US$1,887/ha) and China (US$1,681/ha) lead. India (US$238/ha), Pakistan (US$211/ha) and Uzbekistan (US$246/ha) earn modest returns, while Zambia (US$2/ha), Malawi (US$22/ha) and Tanzania (US$36/ha) barely break even. Türkiye has the highest cultivation cost but earns only slightly above-average returns (US$681/ha). Australia shows that high expenditure can coexist with exceptional profitability when yields are high.

The cost per kilogram of lint is the clearest measure of competitiveness. Against a global average of US$1.59/kg, Cameroon (US$0.93/kg), Uganda (US$0.95/kg) and Australia (US$1.09/kg) are the lowest-cost producers. They reach this position by different routes: minimal expenditure in the two African countries and very high yields in Australia. Zambia (US$3.02/kg), Egypt (US$2.69/kg), Spain (US$2.50/kg) and India (US$2.03/kg) are among the high-cost producers. In India and Zambia, the cause is low yield rather than high expenditure. Ginning outturn, which averages 37%, also affects unit cost. India's 35% compares with 42–43% in Côte d'Ivoire, Brazil and Türkiye, which supports breeding for higher lint recovery without loss of fibre quality.

Water, soil and residue management

Rainfall and irrigation define distinct production environments. Effective seasonal rainfall ranges from 1,329 mm in Ethiopia to just 10 mm in Egypt. The consumptive irrigation footprint averages 2,440 L/kg of lint but reaches 30,303 L/kg in Turkmenistan and more than 10,000 L/kg in Uzbekistan and Egypt. India (581 L/kg) and Brazil (233 L/kg) depend largely on rainfall. In arid producers, improving water productivity through drip and sprinkler irrigation, deficit irrigation and better allocation of water is critical. In rainfed systems, conserving soil moisture during flowering and boll development matters more than seasonal rainfall totals.

Soil-conserving practices remain limited. Conservation tillage covers only 18% of the global cotton area. It is widely adopted in Brazil (75%), Australia (70%) and Zambia (70%) but almost absent in India (3%), Pakistan (0%) and Uzbekistan (0%). Some 13% of cotton stalks are burnt in fields, almost all in Africa: 100% in Mozambique, 95% in Zimbabwe and 90% in Cameroon. Converting these residues into compost or biochar could improve soil organic matter and offer carbon-removal benefits.

Overall, the analysis shows that cotton competitiveness depends not on how much is spent per hectare but on how efficiently land, labour, inputs and water are converted into lint. For the large smallholder economies of Asia and Africa, closing yield gaps through better varieties, timely and appropriate mechanisation, balanced nutrition, integrated pest management and soil and water conservation offers the greatest scope for gains.