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COUNTING THE GREEN PHARMACY[1]

A Satellite Account for Ghana's Traditional Plant Medicine Economy, 2026

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ABSTRACT

Traditional plant medicine supplies primary healthcare to the majority of Ghanaians, yet it appears nowhere in Ghana's national accounts, and the most widely cited valuation of the sector rests on a survey of 27 market stalls conducted in August 2010. This paper constructs the first national-accounts-consistent estimate of the sector for the reference year 2026. Using a 6-layer production approach with Monte Carlo simulation over parameter uncertainty and reporting three distinct aggregates rather than a single headline, final demand for plant medicine is estimated at GHS 11.36 billion, equivalent to USD 988 million, with a 90% credible interval of GHS 8.24 to 15.27 billion, or USD 717 million to USD 1.33 billion. Gross output across the chain is GHS 12.50 billion, or USD 1.09 billion, and value added is GHS 7.55 billion, or USD 657 million, equivalent to 0.50% of gross domestic product. Part of the sector is already measured but misclassified: GHS 3.07 billion, or USD 267 million, of its value already sits inside the national accounts under beverages, agriculture and manufacturing, the largest part through a herbal bitters and tonic channel led by Kasapreko PLC, with turnover of GHS 3.82 billion, or USD 332 million. Correctly attributing the health-service component would raise Ghana's current health expenditure by 11.4% and its health expenditure ratio from 3.95% to 4.40% of gross domestic product. A variance decomposition shows that 93% of the variance of the final demand estimate is carried by three household expenditure parameters, none of which is presently collected by any Ghanaian statistical instrument. The principal policy implication is that a short traditional medicine expenditure module in an existing national household survey would narrow the credible interval to about a quarter of its present width at low cost, and would do more to make the sector visible to policy than any of the regulatory reforms currently under discussion.

Keywords: traditional medicine; satellite accounts; informal economy; national accounting; health financing; Ghana; measurement; indigenous knowledge

JEL classification: E01, I15, O17, O55, Q57

Note on this version. An export value of approximately USD 15 million, some GHS 173 million at this paper's reference rate, was attributed in an earlier version to van Andel et al. (2012). Their published abstract states instead that tonnages of *Griffonia simplicifolia*, *Voacanga africana* and *Fadogia agrestis* are exported annually but that revenue data are scanty. The export leg of this paper is anchored on the Ghana Export Promotion Authority series and not on that study, so no estimate changes; but the correction matters, because the absence of any published export valuation in the primary source is itself part of the measurement problem this paper documents. This version makes further corrections. Population is now the Ghana Statistical Service projection of 34.38 million rather than 35.70 million, which lowers final demand from GHS 11.63 billion to GHS 11.36 billion. Gross output now counts the beverage channel at its attributable value, consistent with final demand. The variance share of the household expenditure parameters is computed exactly, at 93% rather than 95%. The tax, health-account and per capita calculations are restated on explicit bases, and the auxiliary parameters behind them are added to Table 2. The beverage company, Kasapreko PLC, is named, and its listing is correctly dated to June 2026. The titles of Aziato and Antwi (2016) and Asare et al. (2021) had been transposed, and the study of integration at Kumasi South Hospital is now correctly attributed to Boateng et al. (2016). Every reference has been checked against a primary bibliographic record, and one source that could not be so verified has been removed. Citations and the reference list follow APA 7.

Acknowledgements. Prepared for Seminar VI of the Indigenous Enterprises Seminar Series at the University of Ghana. This is the first of three companion papers; the second treats enterprise finance and the third the economics of knowledge disclosure. All estimates and any errors are the author's own.

1. Introduction

Ghana revalues its cocoa crop every season and marks its gold reserves to market every quarter. The last occasion on which it counted its plant medicine economy was 16 years ago, in a survey of 27 market stalls conducted over a single month in 2010 for a botanical journal (van Andel et al., 2012), and that survey was never designed to serve as a national economic estimate. It has served as one ever since, for want of anything better.

The omission is large. Between 60% and 70% of Ghanaians rely on traditional medicine, overwhelmingly plant-based, for primary healthcare (Asase, 2023; Mintah et al., 2022), and the Minister for Health put the figure at about 70% in November 2025 (Ghana News Agency, 2025). The ratio of traditional practitioners to population has been estimated at about 1 to 200 (Busia, 2007, as cited in Asase, 2023), and the Traditional Medicine Practice Council's 2026 count of more than 100,000 practitioners implies about 1 to 340 (Ghana News Agency, 2026), against a doctor to population ratio of 1 to 6,355 in 2020 and a World Health Organization benchmark of 1 to 1,320 (Asase, 2023). On either ratio, traditional practitioners are between 18 and 32 times more numerous relative to population than physicians. Yet the national accounts contain no entry for this activity, the National Health Accounts do not report it as a financing agent or a provider category (Ministry of Health, 2025), the National Health Insurance Scheme does not reimburse it, and the Ghana Statistical Service maintains neither a price series nor a volume series for any of its products.

The consequences are practical. A sector absent from the accounts cannot be given a budget line, cannot be lent against by banks that price only what they can observe, cannot be defended in a trade negotiation, and cannot furnish a baseline against which any future integration policy might be evaluated. Measurement is the first step in developing this industry, and it has never been taken.

This paper takes it and makes three contributions. The first is a national-accounts-consistent estimate of the sector reported as three distinct aggregates rather than as a single headline figure. Final demand, which is the market size properly defined and free of intra-chain double counting, is GHS 11.36 billion, or USD 988 million. Gross output across the chain, which double counts intermediates and is reported only for comparability with existing figures, is GHS 12.50 billion, or USD 1.09 billion. Value added, the contribution to gross domestic product, is GHS 7.55 billion, or USD 657 million, amounting to 0.50% of GDP. Each is reported with a 90% credible interval derived from simulation over the stated parameter ranges.

The second contribution is evidence that part of the sector is already measured but misclassified. Approximately GHS 3.07 billion, or USD 267 million, of plant medicine value already sits inside the national accounts, recorded under beverages, agriculture and manufacturing. The largest single channel is a herbal bitters and tonic industry with turnover of GHS 3.82 billion, or USD 332 million, led by Kasapreko PLC, whose flagship Alomo Bitters is marketed explicitly as a herbal preparation and whose formulation was developed with the state plant medicine research institute. Ghana has already built a multi-billion cedi business

on its own medicinal botany without recording it as such, so the plant medicine sector receives no statistical credit for its most commercially successful application.

The third contribution is a variance decomposition that locates the measurement problem. Some 93% of the variance of the estimate is carried by three parameters governing household expenditure on practitioner services, and none of the three is presently collected by any Ghanaian statistical instrument. This turns a general complaint about data poverty into a specific, low-cost recommendation, developed in Section 8.

The paper proceeds as follows. Section 2 explains why the sector is invisible, tracing the problem to the production boundary in national accounting, to a legal genealogy of concealment beginning in 1878, and to a classification failure that is still operating today. Section 3 reviews the existing evidence base, including the comparative West African market studies that have never been brought to bear on the Ghanaian case, and argues that this evidence cannot support the weight now placed on it. Sections 4 and 5 develop the accounting framework and its parameterisation. Section 6 reports the results, Section 7 interprets them, and Section 8 sets out the policy implications. Section 9 states the limitations. Section 10 identifies the critical research gaps that remain and the methods by which each might be pursued, and Section 11 concludes.

2. Why the Sector Is Invisible

2.1 The production boundary problem

National accounts do not measure all economic activity. They measure activity falling inside a production boundary defined by convention, and the conventions of the System of National Accounts were built around transactions that leave a documentary trace (United Nations et al., 2009). Traditional plant medicine violates almost every assumption on which that trace depends. Much of its raw material is gathered rather than purchased, and gathering from common or customary land generates no receipt. Much of its output is dispensed by a practitioner who keeps no books, in a transaction settled in cash, occasionally in kind, and sometimes deferred against a future obligation that never crystallises into a price at all. Much of its intermediate consumption is self-supplied, since the practitioner who collects their own bark has performed an act of production that the accounts will never see.

None of this is peculiar to Ghana, or to medicine. It is the standard difficulty of measuring household and informal production, a problem first named in the Ghanaian setting by Hart (1973), and the accounting profession has a standard remedy, which is the satellite account. Satellite accounts exist to render visible activity that the core accounts either omit or scatter across categories that obscure its coherence. Tourism, unpaid household work, non-profit institutions and the environment have all been treated in this way, and health has its own well-developed apparatus in the System of Health Accounts (Organisation for Economic Co-operation and Development et al., 2011). Yet, to the author's knowledge, no African country has applied that apparatus to traditional medicine, although traditional medicine is the

majority provider in most of them. The gap is therefore institutional rather than conceptual: the instruments exist but have not been applied to this sector.

2.2 A legal genealogy of concealment

There is a second reason, historical rather than technical. Traditional healing was prohibited in the Gold Coast under the Native Customs Regulation Ordinance of 1878 (Senah, 2001, as cited in Asase, 2023), and for the greater part of the colonial period and into the early independence years the practitioner's relationship to the state was adversarial. In the terms of Scott (1998), remaining illegible to the state was the prudent course. Concealment was a survival strategy rather than a tax strategy; it was rational, and it was transmitted alongside the pharmacological knowledge itself. Twumasi (1975) and Evans-Anfom (1986) both document how deeply that adversarial inheritance shaped the profession's posture toward officialdom.

Formal reversal came slowly, and Kpobi and Swartz (2019) have traced its stages in detail. The Centre for Scientific Research into Plant Medicine, now the Centre for Plant Medicine Research, was established at Mampong-Akuapem in 1975. A Primary Health Training for Indigenous Healers programme sought in the same era to build collaboration between biomedicine and herbalists, priests, traditional birth attendants and traditional surgeons, though an evaluation a decade later found that healers' methods had not changed. The Traditional Medicine Practice Act was passed in 2000 as Act 575, although its Council was not inaugurated until April 2010. The Ghana Herbal Pharmacopoeia, first published in 1992, was revised in 2007, and monographs on medicinal plants followed in 2009 (Asase, 2023). Integration of herbal units into public hospitals began as a pilot in 17 facilities from 2011 (Appiah et al., 2018) and had reached 55 government hospitals by the early 2020s (Asase, 2023).

These are real achievements. But 148 years of institutional habit do not reverse because a Council is inaugurated, and the behavioural residue of that history is the behaviour that defeats measurement: practitioners who will not enumerate, formulations that will not be disclosed, and transactions that leave no record by design. The point matters for method. Under-reporting in this sector is systematic rather than random: its direction is downward, and its magnitude cannot be bounded from the data alone. Any estimation strategy relying wholly on self-reported turnover from practitioners will be biased downward by an unknown amount. The estimation below accordingly anchors its largest layer on the demand side rather than the supply side, for the reasons developed in Section 4.3.

2.3 The classification problem, still operating

The third reason is the most consequential and the least discussed. Where plant medicine value does enter the national accounts, it frequently enters under a heading that severs it from its own sector.

Consider the herbal bitters industry. Its largest producer, Kasapreko PLC, describes its flagship Alomo Bitters as the first scientifically formulated, herbal-based alcoholic beverage in Ghana

and as a blend of tropical plant extracts (Kasapreko PLC, n.d.). The company's research and development unit worked with the Centre for Scientific Research into Plant Medicine, the state's own plant medicine research institute, on that formulation, and Asase (2023) lists Kasapreko among the bitters producers whose raw materials are medicinal herbs. It reported revenue of GHS 3.50 billion, or approximately USD 304 million, in the 2025 financial year (African Markets, 2026), and listed on the Ghana Stock Exchange on 15 June 2026 (Citi Newsroom, 2026). By mid-July its market capitalisation was about GHS 8.35 billion (AFX, 2026), equivalent to approximately USD 726 million at the reference rate used in this paper.

In the national accounts, all of this is beverages. The raw botanical material Kasapreko purchases is agriculture or forestry, or nothing at all where the material is wild-gathered. The gatherers who supply it are counted, if they are counted, as agricultural labour. None of it is attributed to plant medicine.

The same fragmentation operates in smaller ways throughout the sector. Packaged herbal preparations sold through pharmacies may be recorded as pharmaceutical manufacturing or as food supplements depending on their registration route (Gambo et al., 2025). Medicinal plant exports enter the non-traditional export statistics as an agricultural line (Ghana Export Promotion Authority, 2026). Practitioner services, where captured at all, disappear into a residual category of other personal services. The sector is therefore not so much missing from the accounts as dissolved within them, and dissolution is the harder problem, because it cannot be detected by looking for an absence.

3. The Existing Evidence Base and Its Limits

3.1 The single quantitative benchmark

The foundational quantitative study of Ghana's herbal economy is van Andel et al. (2012), published on the basis of fieldwork conducted in August 2010. It remains an excellent piece of botanical market research. Following initial visual surveys, the authors conducted a detailed quantitative survey of 27 stalls, processed market samples into herbarium vouchers, and matched these where possible against fertile vouchers from the field. They recorded 244 medicinal plant products representing between 186 and 209 species, with 14 species sold at more than 25% of the stalls surveyed. Demand was highest for seeds and fruits that double as spice and medicine, namely *Xylopia aethiopica*, *Monodora myristica* and *Aframomum melegueta*, followed by the medicinal barks of *Khaya senegalensis* and *Pteleopsis suberosa*. Plants sold at market were used predominantly for women's health, in ritual, as aphrodisiacs and against sexually transmitted disease. The authors estimated that some 951 tonnes of crude herbal medicine were sold at Ghana's herbal markets in 2010, with a total value of around USD 7.8 million, equivalent to approximately GHS 90 million converted at this paper's reference rate. They further reported that between 20% and 30% of the Ghanaian medicinal flora was encountered during the survey.

These figures are now quoted in policy documents, ministerial speeches and review articles as though they measured the sector. They do not, and the authors made no such claim. Four limits follow from the study's own design. The first is coverage: the survey measured crude botanical material transacted at herbal markets, and did not measure practitioner services, which are by a wide margin the largest component of the sector, nor finished manufactured products, nor exports of processed preparations, nor the substantial volume of material that never transits a market because it is self-collected or supplied under direct contract. The second is species range, since the authors themselves report having encountered only 20% to 30% of Ghana's medicinal flora. The third is vintage: the reference year is 2010, and Ghana's population has since grown from roughly 24.7 million to a projected 34.4 million, the cedi has moved from below 1.5 to the dollar to above 11, and real incomes, urbanisation, the commercialisation of packaged herbal products and the arrival of a large herbal beverage industry have all altered the sector's structure fundamentally. The fourth is purpose, and it is the most important: the study was designed to answer a botanical question about species composition and conservation pressure, not an economic question about sector magnitude. Using it as a national economic estimate is a category error that the economics profession, rather than the botanists, has committed.

One further point of the original paper deserves emphasis, because a common misattribution of it circulates and the correction is instructive. On exports, van Andel et al. (2012) report that tonnages of *Griffonia simplicifolia* and *Voacanga africana* seeds and *Fadogia agrestis* bark are exported annually, but state expressly that revenue data are scanty. They also record that none of these species was found on sale in the domestic markets they surveyed. Secondary summaries have circulated an export figure of roughly USD 15 million, some GHS 173 million at this paper's reference rate, attributed to that study; no such figure appears in its abstract, and it should not be attributed to those authors. The substantive implication is more interesting than the bibliographic one. Ghana's principal medicinal plant exports are species that were not found on sale in Ghana's own herbal markets, and their revenues have never been published in the scholarly record. In the primary literature, the export leg of the plant medicine economy has no valuation at all.

3.2 The regional comparative studies, and why they matter here

A second body of evidence has been almost entirely neglected in the Ghanaian policy debate, although it is directly comparable and produced largely by the same research team using the same protocol. Quiroz et al. (2014) surveyed 22 market stalls across 16 markets in Benin's 8 largest urban areas in 2011 and 2012, recording 307 medicinal products corresponding to approximately 283 species and a market value of USD 2.73 million, equivalent to approximately GHS 31 million at this paper's reference rate. Towns et al. (2014) applied the same protocol to 21 stalls across 14 markets in Gabon in 2012 and valued the main Gabonese markets at about USD 1.5 million a year, approximately GHS 17 million at this paper's reference rate. Mander et al. (2007), working in a different tradition and at national scale, valued the South African traditional medicine trade at R2.9 billion annually, approximately

USD 411 million at 2007 exchange rates or GHS 4.73 billion at this paper's reference rate, representing on their estimate 5.6% of the national health budget, with 27 million consumers, at least 133,000 people employed, and 771 species traded, all of them harvested from the wild.

These studies matter for three reasons. Methodologically, they establish that the Ghanaian market survey was an application of a replicable protocol, which means the 2010 exercise can be repeated and a genuine 16-year comparison constructed. Substantively, they show that Ghana's market-stall trade was roughly three times the size of Benin's, which is a useful check on the plausibility of the Ghanaian benchmark. And analytically, the South African study demonstrates what becomes possible once the exercise is scaled from market stalls to a national trade valuation: Mander et al. (2007) were able to state an employment figure, a consumer count and a share of the health budget, which are the quantities Ghanaian policymakers have never had. The present paper is in that sense an attempt to do for Ghana in 2026 what was done for South Africa in 2007, with the addition of an explicit accounting framework and a treatment of uncertainty.

3.3 The utilisation and integration literature

A third body of work establishes prevalence and institutional progress rather than value. The finding that between 60% and 70% of Ghanaians depend on traditional medicine for primary healthcare is well replicated and appears in the standing review of the sector by Asase (2023), drawing on Mintah et al. (2022) among others. Agyei-Baffour et al. (2017) studied clients' acceptability, perceptions and disclosure of herbal medicine use as it entered mainstream care. Appiah et al. (2018) assessed the integration pilot then running in 17 public hospitals against the World Health Organization health systems framework, finding broad support among key informants alongside calls for the government to fund scale-up. Aziato and Antwi (2016) documented what facilitates and hinders herbal medicine use among clients of an Accra herbal clinic, Asare et al. (2021) examined the facilitators of and barriers to its clinical administration from the perspective of nurses, and Boateng et al. (2016) examined the experience of integration at Kumasi South Hospital directly. Freiesleben et al. (2015) examined the pharmacology of four plants used historically as excipients in Ghanaian herbal preparations. Asase and Peterson (2019), working on the other side of the problem, modelled the effect of climate change on the distribution of *Alstonia boonei*, a commercially significant species.

This literature is indispensable for establishing that the sector matters, that integration is technically feasible, and that its raw material base is ecologically fragile. It is silent on how much the sector is worth. Prevalence is not expenditure, and no Ghanaian study known to the author has bridged them.

3.4 The administrative counts

A fourth body of evidence consists of administrative records. The Traditional Medicine Practice Council had 27,103 registered practitioners as at December 2023 (Ghana News

Agency, 2024), and the Ghana Federation of Traditional and Alternative Medicine reports about 40,000 affiliated practitioners (Asase, 2023). In 2026 the Council's Registrar reported that more than 100,000 practitioners had been identified nationally, of whom fewer than one in five were on its database (Ghana News Agency, 2026). The Food and Drugs Authority maintains a public register of products including a herbal medicines category, under Part 7 of the Public Health Act, 2012, and Gambo et al. (2025) have shown in comparative work that Ghana operates a simplified notification pathway for locally manufactured herbal medicines, with yearly and periodic renewals for products already registered.

These counts are useful but they measure regulatory contact rather than economic activity. A registration roll counts those who chose to register, and in a sector where concealment is rational and registration is costly, the roll is a lower bound of unknown tightness. Worse, its growth over time confounds sector growth with improvements in regulatory reach, so that a rising practitioner count cannot be read as a rising sector without further information that nobody collects.

3.5 The defects in synthesis

Taken together the existing evidence base suffers from five defects that this paper is designed to remedy. It measures the wrong layer, since the most studied component, raw botanical market trade, turns out on the estimates below to be under 3% of final demand, while the largest component, practitioner services, has never been valued at all. It reports point estimates without uncertainty, which invites false precision and produces figures that become immovable once quoted regardless of how weak their foundation was. It has no accounting frame, so that turnover at different stages of a value chain is added together indiscriminately, double counting intermediates and yielding numbers that cannot be compared with GDP or with any other sector. It ignores misclassification entirely, since no existing study of Ghanaian herbal medicine treats the herbal beverage industry as part of the sector despite its scale, its botanical inputs and its own explicit self-description. And it is stale, the most recent economic datum being 16 years old with no institution holding a mandate to refresh it.

4. Method

4.1 A satellite account framework

The analysis follows standard satellite accounting practice, aligned where possible to the classification logic of the System of Health Accounts (Organisation for Economic Co-operation and Development et al., 2011). The object is to identify all resident production of traditional plant medicine goods and services, whether or not the core accounts currently record it, and whether or not they record it under a different heading. Three aggregates are constructed and reported separately, because conflating them is the principal source of confusion in this literature.

Gross output is the sum of turnover at every stage of the chain, with the beverage channel counted at its attributable value (Section 7.2) so that the boundary of the sector is the same

for all three aggregates. It double counts intermediates, since bark sold by a gatherer to a vendor is counted again when the vendor sells it to a practitioner. It is reported for completeness and for comparison with existing figures, which are almost always gross output figures presented as though they were market size, but it should never be quoted as the size of the sector. Final demand is the value of plant medicine goods and services sold to final users, whether households, institutions or the rest of the world. This is market size properly defined, it answers the question a policymaker or investor is actually asking, and it is the headline of this paper. Value added is output net of intermediate consumption at each stage. It is the sector's contribution to gross domestic product and it alone may legitimately be expressed as a percentage of GDP.

4.2 The 6-layer architecture

The sector is decomposed into six layers, chosen so that each has a distinct production technology, a distinct data source and a distinct position in the accounts. Layers are defined so that the output of the raw botanical trade is intermediate to practitioner services, manufacturing and the beverage channel, and gatherer receipts are intermediate to the raw botanical trade. Only the final-user portion of each layer enters final demand.

Table 1. Layer architecture of the plant medicine satellite account

Layer	Activity	Current treatment in the accounts
L1 Gatherers	Wild harvest of bark, root, leaf and seed from forest fringe, fallow, roadside and grove	Absent, or agricultural labour
L2 Raw botanical trade	Market vendors, aggregators, direct supply to manufacturers	Absent, or wholesale and retail trade
L3 Practitioner services	Consultation, diagnosis, and preparations dispensed by the practitioner	Absent
L4 Manufacturers	Packaged herbal medicinal products through pharmacy, over-the-counter, vendor and direct sale	Partly manufacturing, partly absent
L5 Herbal beverages	Bitters and tonic preparations built on medicinal botany	Beverages
L6 Exports	Raw botanical exports and finished herbal product exports	Non-traditional exports, agriculture

4.3 Estimation strategy, and why the largest layer is estimated from demand

Section 2.2 argued that supply-side self-reports in this sector carry a systematic downward bias of unknown magnitude, because concealment is a rational and historically transmitted response to state contact. The estimation strategy responds to this directly. The largest layer, practitioner services, is estimated from the demand side as the product of population, annual utilisation prevalence, episodes per user and expenditure per episode. Utilisation prevalence is the best-established parameter in the entire literature and population is known, which leaves two uncertain quantities whose influence the simulation is designed to expose rather than to conceal.

The manufacturing layer is estimated from a 3-tier firm size structure, because the observed distribution of firms in this sector is strongly right-skewed and applying a mean turnover assumption to a firm count would misstate it badly. The raw botanical layer is anchored on the 2010 benchmark and updated by volume growth, real price growth and a multiplier for non-market channels. The beverage layer is estimated from the disclosed revenue of Kasapreko PLC and its estimated segment share. Exports are estimated from the official non-traditional export series (Ghana Export Promotion Authority, 2026) rather than from the botanical literature, for the reasons given in Section 3.1.

4.4 Monte Carlo over parameter uncertainty

Every uncertain parameter is specified as a triangular distribution over a low, modal and high value, with bounds chosen wide enough that a sceptical reader should accept the interval even where she disputes the mode. Parameters are drawn independently. The simulation takes 200,000 draws and computes the 3 aggregates on each draw, with results reported as means alongside 5th and 95th percentiles.

The simulation carries substantive weight. In a sector this poorly measured, a point estimate is an assertion presented as a finding, and it is likely to be quoted for years without its caveats. A distribution is a more honest object: it invites challenge to specific parameters rather than to the whole exercise, and it permits the variance decomposition in Section 6.3 that carries the paper's most useful policy conclusion.

4.5 The misclassification test

To separate what is missing from what is misfiled, each layer is assigned a share already captured somewhere in the core accounts. The beverage channel is treated as fully captured, under beverages. Raw botanical exports are treated as fully captured, in the non-traditional export statistics. A share of the manufacturing layer, with a modal value of 45%, is treated as captured, corresponding to firms that are incorporated, tax registered and plausibly enumerated in industrial surveys. Practitioner services and the informal portion of the raw botanical trade are treated as wholly uncaptured. The difference between final demand and the captured portion is the sector's statistical dark matter.

4.6 Currency conventions

Every monetary quantity in this paper is reported in both Ghana cedis and United States dollars. Sector estimates for the reference year are converted at GHS 11.50 to the dollar, the Bank of Ghana interbank mid-rate prevailing in July 2026. Ratios to gross domestic product are computed in cedi terms throughout, against nominal GDP of GHS 1.5 trillion, so that the choice of exchange rate cannot contaminate them. Historical and foreign figures drawn from the literature are reported in their original currency and vintage, with a cedi equivalent at the same July 2026 reference rate supplied for scale; such conversions are indicative rather than deflated, and are labelled where they appear. Readers who prefer the implied 2026 period-average rate of GHS 12.68, which reconciles the Budget's cedi GDP with the International

Monetary Fund's dollar GDP of USD 118.29 billion, should scale the dollar figures in this paper by 0.91; the cedi figures and every GDP ratio are unaffected.

5. Data and Parameterisation

The reference year is 2026 and all values are in current prices. Nominal gross domestic product is taken as GHS 1.5 trillion, the projection in the 2026 Budget Statement (Ministry of Finance, 2025), against which the International Monetary Fund (2026) reports USD 118.29 billion. Population is 34.38 million, the Ghana Statistical Service projection for 2026 (Ghana Statistical Service, 2026a), and projected tax revenue is GHS 223.9 billion, or approximately USD 19.5 billion. Inflation stood at 5.3% in June 2026 (Ghana Statistical Service, 2026b), having fallen from 23.8% at the end of 2024, and real growth was 6.0% in 2025 with 4.9% projected for 2026. On the health side, the Ghana National Health Accounts for 2018 to 2022 report current health expenditure rising from 2.61% to 3.95% of GDP over that period, with per capita spending of GHS 715.38, reported in the source as USD 83.42, in 2022, and out-of-pocket payments falling from 33.48% to 25.03% of current health expenditure (Ministry of Health, 2025).

Table 2 records every parameter, its distribution and its provenance. It is the core of the paper. A reader who disagrees with the result should be able to identify which row is responsible and substitute a preferred value, and the accompanying workbook permits exactly that. Parameters described as author estimates are judgements, and are offered for correction rather than presented as findings.

Table 2. Parameters, distributions and sources

Parameter	Low	Mode	High	Source or basis
L3 annual utilisation prevalence	0.45	0.57	0.70	Utilisation literature; 60% to 70% dependence, adjusted to annual episode incidence
L3 episodes per user-year	1.6	2.6	4.0	Author estimate
L3 spend per episode, GHS	60	115	200	Author estimate from 2026 retail and consultation pricing
L4 top-tier firms (count)	6	10	16	FDA register; industry association membership
L4 top-tier turnover, GHS m	25	60	130	Author estimate from firm disclosures and employment
L4 mid-tier firms (count)	25	45	75	FDA register
L4 mid-tier turnover, GHS m	5	12	25	Author estimate
L4 small-tier firms (count)	150	280	480	FDA register; TMPC premises licences
L4 small-tier turnover, GHS m	0.4	1.5	3.5	Author estimate
L2 volume growth 2010 to 2026	1.45	1.70	2.10	Population growth of 39% plus urbanisation
L2 real unit price growth	1.10	1.35	1.70	Scarcity; *Khaya senegalensis* bark now imported (Asase, 2023)

Parameter	Low	Mode	High	Source or basis
L2 non-market channel multiplier	2.0	3.2	4.8	Direct contract supply, own collection, industrial buyers
L1 gatherer share of vendor price	0.22	0.32	0.45	Author estimate from value chain structure
L5 Kasapreko revenue growth to 2026	1.12	1.25	1.40	FY2025 revenue GHS 3.50bn, up from GHS 0.95bn five years earlier
L5 alcoholic share of Kasapreko revenue	0.50	0.60	0.70	Company portfolio disclosure
L5 herbal share of alcoholic revenue	0.55	0.68	0.80	Bitters and tonic wine within the portfolio
L5 Kasapreko share of bitters segment	0.35	0.47	0.60	Author estimate; historic share above 50%, discounted for newer entrants
L5 botanical input share of turnover	0.03	0.055	0.09	Author estimate of raw material cost structure
L5 attributable share for the account	0.20	0.30	0.45	Formulation-attributable value; see Section 7.2
L6 medicinal plant share drift vs 2013	0.55	0.90	1.35	GEPA NTE series; USD 43.1m in 2013 scaled by NTE growth
L6 finished product exports, USD m	6	15	32	Author estimate from exporting firms
L2 final-use share of output	0.20	0.26	0.32	Reconstructed from the reported L2 split in Table 3
L4 share already captured	0.35	0.45	0.55	Incorporated, tax-registered firms; Section 4.5
Value-added ratio, L1 gatherers	0.80	0.85	0.90	Calibrated; minimal purchased inputs
Value-added ratio, L2 trade	0.40	0.50	0.60	Calibrated; net of purchases from gatherers
Value-added ratio, L3 practitioners	0.64	0.71	0.78	Calibrated; net of botanical and premises costs
Value-added ratio, L4 and finished exports	0.35	0.45	0.55	Calibrated
Value-added ratio, L5 attributable turnover	0.45	0.55	0.65	Calibrated
Value-added ratio, L6 raw exports	0.20	0.30	0.40	Calibrated; exporter margin
Labour share of value added	0.55	0.65	0.75	Author estimate; informal, labour-intensive sector
Annual participant earnings, GHS thousand	9.0	18.0	28.0	Author estimate

Source: author's construction; bases as listed. All distributions triangular and drawn independently. A United States consumer price uplift of 1.48 is applied to the 2010 benchmark before real growth adjustment. The 2013 medicinal plant export figure of USD 43.1 million is scaled by the ratio of 2025 to 2013 non-traditional export earnings (2.06) and is equivalent to approximately GHS 496 million at this paper's reference rate.

6. Results

6.1 Layer estimates

Table 3 reports the simulated distribution for each layer. Practitioner services dominate at GHS 6.73 billion, or USD 585 million, which is 59% of final demand. The raw botanical trade,

the only layer for which a prior quantitative estimate existed, is GHS 1.07 billion of gross output, or USD 93 million, of which only GHS 0.28 billion, or USD 24 million, reaches households as final demand. The great majority of what has previously been measured in this sector is therefore intermediate consumption for a layer that has never been measured at all.

Table 3. Layer estimates, reference year 2026

Component	GHS bn 5%	GHS bn mean	GHS bn 95%	USD m mean	% GDP
L1 Gatherer receipts (output)	0.22	0.35	0.52	31	0.02
L2 Raw botanical trade (output)	0.73	1.07	1.47	93	0.07
of which final to households	0.17	0.28	0.42	24	0.02
L3 Practitioner services	3.75	6.73	10.54	585	0.45
L4 Manufacturers	1.32	1.99	2.76	173	0.13
L5 Herbal beverage channel (turnover)	2.92	3.82	4.89	332	0.25
of which attributable to the sector	0.81	1.21	1.70	105	0.08
of which botanical input purchases	0.14	0.22	0.33	19	0.01
L6 Exports, total	0.87	1.16	1.47	101	0.08
of which raw botanical	0.69	0.96	1.25	83	0.06
of which finished products	0.11	0.20	0.31	18	0.01

Author's calculations from 200,000 Monte Carlo draws. Converted at GHS 11.50 per USD. GDP shares computed in cedi terms against nominal GDP of GHS 1.5 trillion. Components may not sum exactly because of rounding.

6.2 Headline aggregates

Table 4 reports the three aggregates. Final demand for traditional plant medicine in Ghana in 2026 is estimated at GHS 11.36 billion, equivalent to USD 988 million, with a 90% credible interval from GHS 8.24 to GHS 15.27 billion, or USD 717 million to USD 1.33 billion. Value added is GHS 7.55 billion, or USD 657 million, amounting to 0.50% of gross domestic product with an interval of 0.36% to 0.69%.

Table 4. Headline aggregates, reference year 2026

Aggregate	GHS bn 5%	GHS bn mean	GHS bn 95%	USD m mean	% GDP
Gross output across the chain	9.34	12.50	16.43	1,087	0.83
Final demand (market size)	**8.24**	**11.36**	**15.27**	**988**	**0.76**
Value added (GDP contribution)	5.35	7.55	10.32	657	0.50

Source: author's calculations from 200,000 Monte Carlo draws; gross output counts the beverage channel at its attributable value. Only value added may legitimately be expressed as a share of GDP. The final demand share is shown for orientation only.

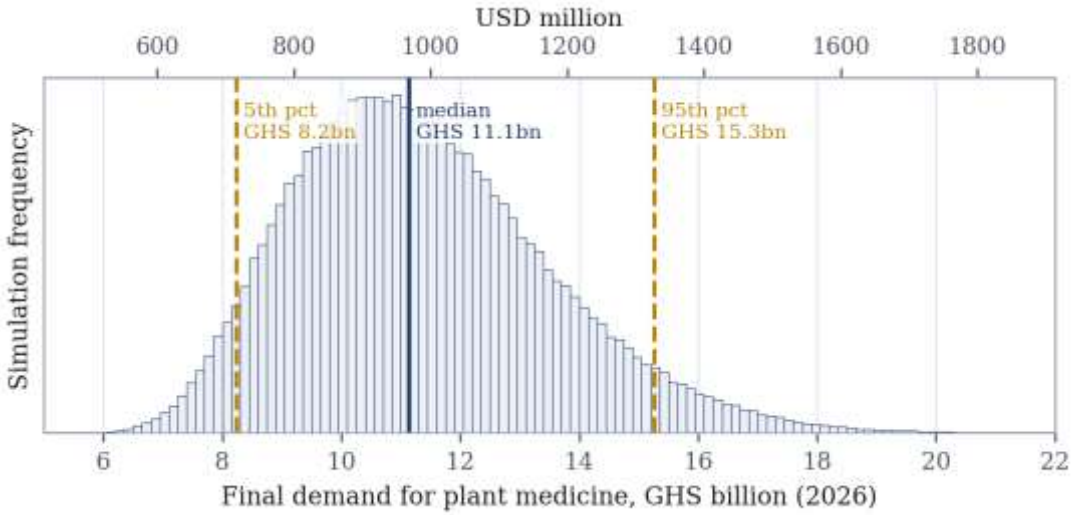

Figure 1. Simulated distribution of final demand for traditional plant medicine, Ghana, 2026. The distribution is right-skewed, so the mean of GHS 11.36 billion exceeds the median of GHS 11.13 billion and the upper tail is materially longer than the lower.

Figure 2. Composition of final demand by layer. Practitioner services account for 59% of the sector; the layer the existing literature measures contributes under 3%.

Per capita, household spending on plant medicine goods and services, excluding the beverage channel and exports, is approximately GHS 262, or USD 22.80, a year. For orientation, current health expenditure per capita was GHS 715, reported as USD 83, in 2022 (Ministry of Health, 2025). Restated to 2026 on the basis used in Section 6.5, it is approximately GHS 1,720, or USD 150, so household plant medicine spending is equivalent to about 15% of it. That spending is almost entirely out of pocket and carries no insurance protection.

6.3 Where the uncertainty lives

Figure 3 decomposes the variance of the final demand estimate by parameter, using the squared Spearman rank correlation of each input with final demand, normalised to sum to 100%. For policy purposes this is the most useful finding in the paper. Expenditure per episode alone carries 54% of the variance, episodes per user-year a further 32%, and utilisation prevalence 7%. Together these three account for 93%. Because final demand is the sum of

practitioner services and components that are independent of them, the combined share can also be computed exactly, as one minus the ratio of the variance of the other components to that of final demand; the exact figure is also 93%. The remaining parameters, which span the manufacturing, raw botanical, beverage and export layers, contribute 7% between them.

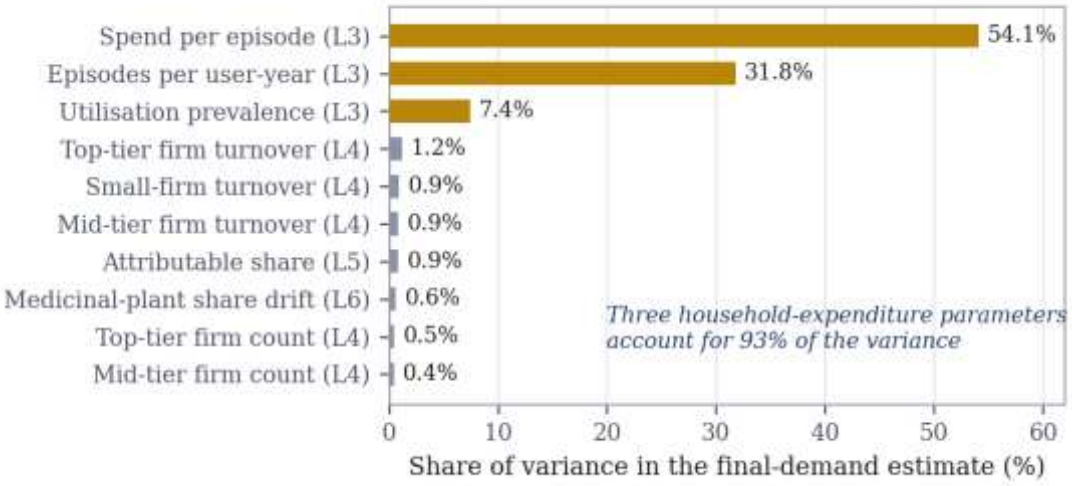

Figure 3. Variance decomposition of the final demand estimate. Three household-expenditure parameters account for 93% of the variance.

Uncertainty in this estimate is therefore concentrated in three household expenditure quantities, each of which could be measured by adding a short module to an existing nationally representative household survey. The Ghana Living Standards Survey and the Annual Household Income and Expenditure Survey are both fielded on established cycles and both already collect health expenditure. Neither disaggregates traditional medicine. Adding that disaggregation would cost little relative to the survey budget. If the three quantities were known exactly, the standard deviation of the estimate would fall to about a quarter of its present value (the square root of the 7% residual share is 0.26), and the 90% interval would narrow in the same proportion; sampling error in the new module would offset part of that gain.

6.4 Missing, or misfiled?

Of the GHS 11.36 billion in final demand, approximately GHS 3.07 billion, or USD 267 million, already sits inside the national accounts under another heading, leaving GHS 8.29 billion, or USD 721 million, absent altogether. The misfiled portion is dominated by the herbal beverage channel and by raw botanical exports. Both are recorded, and neither is recorded as plant medicine.

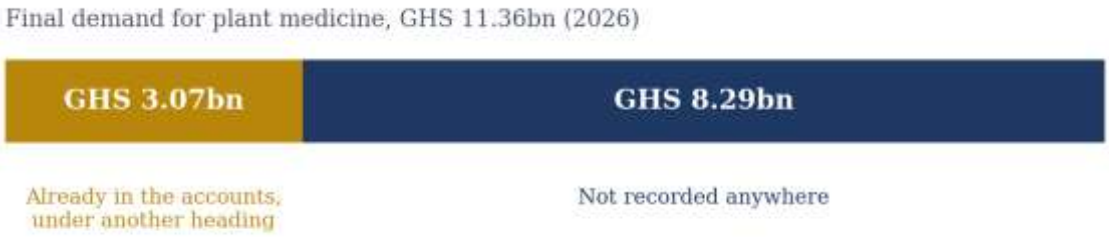

Figure 4. Decomposition of final demand into value already recorded under another heading, GHS 3.07 billion or USD 267 million, and value not recorded at all, GHS 8.29 billion or USD 721 million.

This distinction matters for policy design. Value that is missing requires new measurement instruments and therefore new fieldwork, new budgets and new institutional mandates. Value that is misfiled requires only a reclassification exercise and a satellite table, which is cheaper, faster, and can be carried out retrospectively from data the Ghana Statistical Service already holds. A government wishing to make immediate progress on this sector should begin with the second, because it can be delivered within a single statistical cycle and it demonstrates the value of the exercise before the expensive part begins.

6.5 Restating the health accounts

Traditional medicine does not appear as a distinct provider or financing category in the Ghana National Health Accounts (Ministry of Health, 2025). Applying the 2022 ratio of 3.95% to 2026 nominal GDP, on the assumption that the ratio has been broadly stable since 2022, gives current health expenditure of approximately GHS 59.2 billion, or USD 5.15 billion. Adding practitioner services, the health-service component of the sector, which no part of the health accounts currently captures, raises this by GHS 6.73 billion to GHS 66.0 billion, or USD 5.74 billion, an uplift of 11.4%, and raises the health expenditure ratio from 3.95% to 4.40% of gross domestic product. Adding also the uncaptured household purchases of raw and packaged herbal medicines, a further GHS 1.37 billion, would raise the uplift to 13.7% and the ratio to 4.49%.

The consequences run beyond bookkeeping. Ghana's progress toward universal health coverage is monitored using exactly these ratios. If more than 10% of national health spending is invisible to the monitoring framework, the framework is systematically understating both the resources the population devotes to health and, more importantly, the extent of unprotected out-of-pocket exposure. Every cedi of the GHS 6.73 billion, or USD 585 million, identified here is spent without insurance cover, because herbal medicines remain outside the National Health Insurance Scheme. Financial protection indicators computed without it are biased in a known direction: they understate household exposure.

6.6 Employment and fiscal magnitudes

Applying a labour share of 55% to 75% of value added and dividing by plausible annual participant earnings of GHS 9,000 to GHS 28,000, or roughly USD 780 to USD 2,430, implies between 166,000 and 451,000 livelihoods substantially dependent on the sector (5th and 95th

percentiles), with a mean of approximately 281,000. This is an order-of-magnitude figure and should be read as such, but it is consistent with the registration and association counts once unregistered vendors and gatherers are included, and it sits plausibly against the 133,000 employed in South Africa's smaller trade as estimated by Mander et al. (2007). In South Africa such livelihoods are disproportionately held by rural women (Mander et al., 2007), and a similar pattern is plausible in Ghana.

On foregone revenue, an indicative calculation applying a blended effective rate of 4% to 10% to domestic final demand not already in the tax net, which is practitioner services, household purchases of raw botanicals and the uncaptured share of manufacturing, together GHS 8.10 billion, yields GHS 0.32 to 0.81 billion a year, or USD 28 million to USD 70 million. That is between 0.14% and 0.36% of projected 2026 tax revenue of GHS 223.9 billion. Section 7.4 argues that this is the least important number in the paper and explains why it is nonetheless reported.

6.7 Benchmarks and regional comparison

Table 5 places the estimate against domestic comparators. The sector is more than three times the revenue of Kasapreko PLC, whose flagship product is itself a herbal preparation. Its exports are approximately 2% of Ghana's non-traditional export earnings, which stood at USD 5.007 billion, or GHS 57.6 billion, in 2025 (Ghana Export Promotion Authority, 2026).

Table 5. The plant medicine sector against domestic comparators, 2025 to 2026

Comparator	GHS bn	USD m	Sector as % of comparator
Plant medicine sector, final demand (this paper)	**11.36**	**988**	**n.a.**
Ghana non-traditional exports, 2025	57.58	5,007	19.7
Kasapreko PLC, market capitalisation, mid-July 2026	8.35	726	136.0
Kasapreko PLC, revenue FY2025	3.50	304	324.6

Source: author's calculations. Comparator values from Ghana Export Promotion Authority (2026), African Markets (2026) and AFX (2026), converted at GHS 11.50 per USD. Kasapreko PLC listed on 15 June 2026; the market capitalisation shown is at a share price of GHS 2.00 in mid-July 2026.

Table 6 sets the estimate against the regional literature, and the comparison is instructive in a way that the domestic benchmarks are not. Ghana's market-stall trade in 2010 was roughly 3 times Benin's in 2011 and 2012, which is consistent with relative population and urbanisation and lends confidence to the benchmark. South Africa's national trade valuation, at approximately USD 411 million in 2007 or GHS 4.73 billion at this paper's reference rate, is of the same order as the present estimate of the raw and manufactured components of Ghana's sector, about GHS 3.06 billion, or USD 266 million. The comparison is loose, since the two figures differ in vintage, price base and scope, but it is the nearest available external check. Among the countries compared here, only South Africa has a national trade valuation, and it is now 19 years old.

Table 6. Comparable valuations of African traditional medicine markets

Study	Country and year	Scope	Value, original	Value, GHS m at 2026 rate
van Andel et al. (2012)	Ghana, 2010	27 market stalls	USD 7.8m	90
Quiroz et al. (2014)	Benin, 2011 to 2012	22 stalls, 16 markets	USD 2.73m	31
Towns et al. (2014)	Gabon, 2012	21 stalls, 14 markets	USD 1.5m	17
Mander et al. (2007)	South Africa, 2007	National trade valuation	R2.9bn (USD 411m)	4,727
This paper	**Ghana, 2026**	**Full sector, six layers**	**USD 988m**	**11,360**

Cedi equivalents are indicative conversions at GHS 11.50 per USD and are not deflated to a common price base. Source: author's compilation from the studies listed.

7. Discussion

7.1 What the number means, and what it does not

The headline of approximately USD 1 billion, or GHS 11.36 billion, should be understood as a market size and not as a contribution to output. The contribution to gross domestic product is GHS 7.55 billion, or USD 657 million, about 0.5%. Both are correct answers to different questions, and reporting both is what this literature has lacked.

A share of 0.5% of GDP may sound modest against the rhetoric that surrounds this sector, and two observations should temper that reaction. The first is that it is generated in a sector with essentially no capital investment, no formal credit, no insurance reimbursement and no export standard, so it is what the sector produces under those constraints. The second, and more important, is that the relevant comparison is with the health system rather than with GDP, because this is a provider of primary healthcare to the majority of the population whose economic weight has never entered a health financing calculation.

7.2 On the tonic and beverage channel

The treatment of the herbal beverage channel requires defence, since it is the most contestable methodological choice in the paper. Three positions are available. The maximal position counts the entire GHS 3.82 billion, or USD 332 million, of channel turnover as plant medicine, on the grounds that the products are formulated from medicinal species, marketed on their herbal identity, and, in Kasapreko's case, developed with the state plant medicine institute. This overstates the case, because a substantial part of the value in a bottle of bitters is alcohol, sugar, glass, brand and distribution rather than botany. The minimal position counts only botanical input purchases, estimated at GHS 0.22 billion, or USD 19 million. This understates the case badly, because it treats the medicinal formulation as a commodity input rather than as the differentiating asset it evidently is; nobody pays a premium for the alcohol.

An intermediate position is therefore taken, attributing 20% to 45% of channel turnover with a modal value of 30%, giving GHS 1.21 billion or USD 105 million. The reasoning is that the herbal formulation is the product's core differentiator and its principal source of pricing power, and the band is wide enough to span materially different views of how much of a

bottle's value the formulation commands. The parameter appears explicitly in Table 2 and contributes under 1% of total variance within the band adopted here. The extremes are a different matter: the maximal position would raise final demand by about GHS 2.6 billion, or 23%, to roughly GHS 14.0 billion, and the minimal position would lower it by about GHS 1.0 billion, or 9%, to roughly GHS 10.4 billion. A reader who prefers either may substitute it directly.

What is not contestable is the underlying observation. Ghana has already built a multi-billion cedi enterprise on its own medicinal botany; that enterprise, Kasapreko PLC, listed on the national stock exchange in June 2026 and was valued at about GHS 8.35 billion, or USD 726 million, a month later; and the plant medicine sector receives no statistical credit for it. The country evidently knows how to industrialise its pharmacopoeia; its largest success in doing so is classified as a drink.

7.3 The export leg and the shape of value escape

The export findings deserve separate emphasis because they bear on industrial policy rather than on measurement alone. Raw botanical exports are estimated at GHS 0.96 billion, or USD 83 million, against finished herbal product exports of GHS 0.20 billion, or USD 18 million. Ghana therefore exports unprocessed medicinal biomass at roughly five times the value of the finished preparations it sells abroad.

The composition of that raw trade is more striking than its magnitude. van Andel et al. (2012) recorded that *Griffonia simplicifolia*, *Voacanga africana* and *Fadogia agrestis*, the species that leave Ghana in tonnage, were not found on sale in the domestic markets they surveyed. On that evidence, the leading export species and the domestic market basket barely overlap. Ghana appears to be supplying a separate industrial demand, in raw form, rather than exporting a surplus of what its own healers use, and the revenues from that trade have never been published in the scholarly literature. *Griffonia* leaves as seed and returns to the world as 5-hydroxytryptophan; the value added accrues where the processing happens. This is the classical structure of commodity dependence reproduced inside the health sector, and it is invisible in the accounts because the export line is filed under agriculture.

7.4 Why the fiscal argument is the weak one

The estimate of GHS 0.32 to 0.81 billion, or USD 28 million to USD 70 million, in foregone revenue will attract disproportionate attention and deserves very little. Most units in this sector are small, as informal enterprises generally are (La Porta & Shleifer, 2014), and would fall below income tax thresholds even if fully registered, so the realistically recoverable amount is a fraction of the notional figure, and the administrative cost of collecting it from upwards of 250,000 micro-units would consume much of what was raised.

The figure is reported for two reasons. The first is completeness, since an accounting exercise that omits the fiscal dimension invites the suspicion that it was omitted because it was inconvenient. The second is that the case for measuring this sector is stronger when its weakest version is conceded at the outset. The case rests instead on the fact that an

unmeasured sector cannot be budgeted for, lent to, insured, exported at standard, or defended in a benefit-sharing negotiation, and that each of those foreclosures costs the country more every year than the entire notional tax yield.

8. Policy Implications

Recognition of this sector, in practical terms, means a budget line, a reimbursement code and a row in the national accounts. The variance decomposition in Section 6.3 yields a specific recommendation about where to begin.

The three parameters that carry some 93% of the variance in the national valuation of this sector could be measured directly by adding a short traditional medicine expenditure module to the Ghana Living Standards Survey or the Annual Household Income and Expenditure Survey. The module requires three questions: whether any household member consulted a traditional practitioner or purchased a herbal preparation in the reference period, how many times, and how much was spent. Both surveys already carry a health expenditure section into which the questions would fit with little additional interview time, so the marginal cost is low, and the return is that Ghana would for the first time know the size of a sector serving the majority of its population. No other measurement intervention in Ghanaian statistics is known to the author with a comparable ratio of information gained to cost incurred.

Beyond the survey module, four steps would institutionalise the account. The Ghana Statistical Service should be mandated, jointly with the Ministry of Health and the Bank of Ghana, to publish a traditional medicine satellite account on a defined cycle, in the manner of the tourism satellite account. The misfiled GHS 3.07 billion, or USD 267 million, identified in Section 6.4 should be recovered immediately and retrospectively from data already held, by tagging the relevant industrial and product classification codes and publishing a bridge table, an exercise requiring no new fieldwork. The National Health Accounts should carry traditional medicine as a distinct provider and financing category under the System of Health Accounts, so that the 11.4% understatement documented in Section 6.5 is corrected within the universal health coverage monitoring framework. And the Ghana Export Promotion Authority should report medicinal plants and finished herbal products as separately identified lines, with volume as well as value, so that the raw-versus-processed composition of the export basket becomes visible to anyone designing industrial policy for the sector.

The wider argument is that measurement is a precondition for policy, and six consequences follow from having a number. A sector with a satellite account can be given a budget line, an industrial policy and a place in the medium-term expenditure framework, and a sector without such an account cannot. Banks price what they can observe, so published sector accounts, price series and volume series are the raw material of credit appraisal and their absence is a first-order explanation of why this sector cannot borrow. A reimbursement decision requires a costed utilisation baseline, and the estimates here provide the first one while also showing that the population already spends GHS 6.73 billion, or USD 585 million, a year on health services with no financial protection at all. An export standard and an African Continental Free

Trade Area negotiating position both require knowing the size and composition of what is currently exported, which Section 7.3 shows to be overwhelmingly raw. A country with no valuation of its plant medicine economy has no basis on which to claim a share when its biodiversity is commercialised abroad, so that under the Nagoya Protocol this is not primarily a legal problem but an accounting one. And without a baseline no future integration policy can ever be shown to have worked, which condemns every incoming minister to relitigate the case from zero.

9. Limitations

Five limitations should be stated plainly. The first and most serious is that the largest layer rests on assumed parameters: expenditure per episode and episodes per user-year are author judgements bounded by plausibility rather than measured quantities, and they carry 86% of the variance between them. This is disclosed in Table 2, quantified in Figure 3, and is the direct motivation for the recommendation in Section 8. The estimate should be treated as the best available construction from existing evidence, not as a measurement.

The second is that the 2010 anchor is doing work it was not designed for. Updating a 27-stall market survey by 16 years of volume and price growth is a defensible procedure but it compounds uncertainty; it also relies on a United States price index and a 2026 exchange rate to uprate a 2010 dollar value, which assumes that cedi depreciation since 2010 has tracked relative inflation, and the raw botanical layer should be re-measured by direct survey. The third is that own-account production is imperfectly handled: a practitioner who gathers their own bark has produced an input that never transits a market, and the layer structure treats such material within practitioner output rather than separately, which is internally consistent but means the raw botanical layer understates total botanical throughput. The fourth is that the beverage attribution is a judgement; Section 7.2 defends the 30% modal value and shows that the headline is insensitive to it within the adopted band, though not to the extreme positions, which a reader may legitimately prefer.

The fifth is that no primary data were collected. This paper is a construction from secondary sources, administrative records, published company accounts and the peer-reviewed literature. It is intended to establish the framework, to demonstrate that the exercise is feasible, and to identify which quantities would need to be measured to convert it into a measurement proper. It is a first approximation offered for correction, and it will have succeeded if it is superseded.

10. Critical Research Gaps and an Advanced Research Agenda

Each of the limitations above identifies a research gap that is tractable with existing methods, and several are tractable at low cost by researchers who have not previously seen this sector as an economic subject. What follows sets out the nine gaps judged most consequential, in each case with the method by which it might be pursued and, where relevant, the data that

would have to be secured. They are ordered by the ratio of expected contribution to expected difficulty rather than by intellectual ambition.

10.1 The household expenditure gap

This is the binding constraint and it is the cheapest to relieve. The requirement is a nationally representative measurement of traditional medicine utilisation frequency and expenditure per episode, disaggregated at minimum by region, residence, sex and consumption quintile. The obvious route is a module within the Ghana Living Standards Survey or the Annual Household Income and Expenditure Survey, and the obvious research contribution is to design and cognitively pre-test that module so that a statistical office can adopt it without further development work. Two refinements are worth pursuing. Recall error is likely to be severe for low-value, high-frequency purchases of the kind this sector generates, so a diary sub-sample validated against recall responses would be methodologically valuable in its own right and would speak to a live debate in household survey measurement. And mobile money transaction records, now covering a large share of Ghanaian retail payment, offer an independent and largely unexploited source of expenditure data on registered herbal vendors, subject to negotiated access and appropriate anonymisation. A paper triangulating survey recall, diary and transaction data on the same population would be publishable on measurement grounds alone, quite apart from what it revealed about plant medicine.

10.2 Re-measuring the raw botanical trade

The 2010 market survey should be replicated. The protocol is published, the research team that developed it also applied it in Benin and Gabon (Quiroz et al., 2014; Towns et al., 2014), and the instrument is therefore standardised across three countries. A replication at the same markets in 2026 would yield the first genuine volume and real-price panel for an African medicinal plant trade, which is a contribution to resource economics and conservation biology as much as to national accounting. Three extensions suggest themselves. Species-level price series would permit estimation of scarcity rents and, by comparison with the 2010 species list, direct measurement of commercial extinction at the market level, which speaks to the concern van Andel et al. (2012) raised and which Asase and Peterson (2019) approached from the modelling side. Botanical vouchering combined with DNA barcoding would quantify substitution and adulteration rates, on which Srirama et al. (2017) have shown the international evidence to be alarming, while Ghanaian evidence is absent. And a supply-chain census upstream of the market, tracing material back to gathering sites, would populate the gatherer layer that this paper is obliged to estimate as a residual share of the vendor price.

10.3 Own-account production and the household production boundary

The treatment of self-collected material is the weakest conceptual joint in the framework. A practitioner who gathers their own bark, and a household that boils its own decoction from a plant taken from a fallow, are both producing, and the System of National Accounts has established conventions for such cases (United Nations et al., 2009) that have never been applied here. The research route is a time-use module attached to the survey work in Section

10.1, valuing gathering and preparation labour at a defensible shadow wage, which would also generate the first estimate of the sector's unpaid labour input. This is the analytical territory of the unpaid household work satellite accounts developed elsewhere, and importing that apparatus into traditional medicine would be a methodological contribution in its own right.

10.4 The beverage channel, now that its accounts are public

The attribution parameter in Section 7.2 is a judgement because the necessary cost-structure data were not in the public domain. That changed in June 2026. The listing of Kasapreko PLC on the Ghana Stock Exchange brings with it continuing disclosure obligations, audited segment reporting and a published prospectus, which together make it possible to replace the assumed attribution with an estimated one. Two complementary methods are available. An input-output or cost-build approach would use disclosed raw material, packaging, excise and distribution costs to isolate the residual attributable to formulation and brand. A hedonic approach would regress retail prices across the bitters segment on product attributes, including the presence and prominence of herbal claims and of plant medicine certification, to recover the market price of the herbal characteristic directly. Either would convert the most contestable number in this paper into an estimate, and the hedonic route would additionally produce the first quantification of what Ghanaian consumers actually pay for a herbal claim, which bears directly on the regulation of therapeutic advertising.

10.5 The export leg, mirror statistics and the patent landscape

Section 7.3 identifies the export composition as among the most policy-relevant findings in the paper and among the least well evidenced. Three methods would address this. Mirror statistics, comparing Ghana's reported exports of the relevant tariff headings against partner countries' reported imports from Ghana of the same headings, is the standard technique for detecting misinvoicing and under-recording in commodity trade and has not, to the author's knowledge, been applied to Ghana's medicinal plant exports. Unit-value analysis along the chain, comparing the export price of *Griffonia* seed against the import price of the derived compound, would quantify the value escape that Section 7.3 describes only qualitatively. And a patent landscape analysis of the principal exported species, coded by assignee nationality and by the presence or absence of any recorded benefit-sharing arrangement, would establish whether Ghanaian institutions or communities appear anywhere in the intellectual property record for their own biodiversity. That third exercise belongs properly to a companion paper on the economics of knowledge disclosure, which takes up the appropriability problem set out by Arrow (1962), but its trade component belongs here.

10.6 Regional, sub-national and distributional decomposition

The estimates in this paper are national, which is the level at which they are least useful to the officials who must act on them. A district-level decomposition is feasible by linking the Traditional Medicine Practice Council register to census and district health information data, and would permit spatial analysis of the substitution between traditional and biomedical provision as a function of facility distance, insurance enrolment and poverty. The

distributional question is equally open and more urgent: because plant medicine is financed almost entirely out of pocket and is used disproportionately by poorer and rural households, its incidence is likely to be regressive, and a benefit-incidence analysis would quantify how much of the sector's burden falls on the bottom quintiles. The gender dimension warrants separate treatment, since the gendered division of labour along the chain, from gathering and market vending to manufacturing and export, has not been documented for Ghana; a value-chain analysis with gendered value capture at each layer is a paper in its own right.

10.7 A price index for plant medicine

There is no price index for this sector, which means that even if the level were measured today it could not be tracked tomorrow, and any future estimate would face the same deflation problem that forced this paper to uprate a 2010 dollar figure by a United States price index. Constructing a plant medicine consumer price sub-index, from the species-level market prices proposed in Section 10.2 together with retail prices for packaged preparations, is unglamorous and indispensable. It is also the component most likely to be adopted permanently by a statistical office, because once built it costs almost nothing to maintain and it slots into machinery that already exists.

10.8 Causal evaluation: the staggered rollout as a natural experiment

The most promising identification opportunity in this literature appears to have gone unused. Herbal medicine units were introduced into Ghanaian public hospitals progressively, beginning with a pilot in 17 facilities from 2011 (Appiah et al., 2018) and reaching 55 by the early 2020s (Asase, 2023). That is a staggered adoption design. With facility-level adoption dates and the routine health information system, it is possible to estimate the causal effect of integrating a herbal unit on outpatient volumes, on the treatment mix, on out-of-pocket expenditure and potentially on outcomes, using difference-in-differences estimators for staggered treatment timing (Callaway & Sant'Anna, 2021). This would answer the question that 15 years of Ghanaian debate has not settled, namely whether integration does anything measurable, and it would do so with a credible research design rather than with key-informant opinion. The principal obstacle is administrative: the adoption dates are not published in a consolidated form and would have to be reconstructed from Ministry of Health records. Reconstructing that timeline is itself a worthwhile piece of research and a precondition for everything else.

10.9 The comparative programme, and where the frontier lies

Finally, the framework developed here is not Ghana-specific. To the author's knowledge, no African country maintains a traditional medicine satellite account, and traditional medicine is the majority provider in most of them. The harmonised layer template in Table 1 could be applied to Benin and Gabon, which already have market-stall studies on the common protocol, to South Africa, which has a national trade valuation, and to Nigeria, which has neither. A multi-country comparative satellite account would establish the method in the international literature, provide the external validation that a single-country estimate cannot, and offer the

Global Traditional Medicine Strategy 2025 to 2034 (World Health Organization, 2025) a practical economic measurement framework for the sector whose development it commits its members to pursue. That is where the frontier lies, and Ghana is well placed to lead it, having both the botanical endowment and, after this paper, a template.

11. Conclusion

Traditional plant medicine in Ghana is a sector of approximately GHS 11.36 billion, or USD 988 million, in final demand, contributing GHS 7.55 billion, or USD 657 million, in value added, which is 0.50% of gross domestic product in the reference year 2026. Roughly a quarter of that value already sits inside the national accounts under other headings, principally beverages and agricultural exports, and the remaining GHS 8.29 billion, or USD 721 million, is recorded nowhere. Correcting the health-service component alone would raise Ghana's measured current health expenditure by 11.4% and reveal GHS 6.73 billion, or USD 585 million, of annual household health spending carrying no insurance protection of any kind. Exports are approximately GHS 1.16 billion, or USD 101 million, of which 5 parts in 6 leave the country as unprocessed biomass, largely in species not found on sale in Ghana's own markets.

These figures are a first approximation and they are reported with intervals wide enough to make that plain. The width of the interval is itself a finding: 93% of its variance is attributable to three household expenditure quantities that no Ghanaian statistical instrument currently collects and that existing surveys could collect at low cost. The core of Ghana's plant medicine data problem can be addressed with three questions on a survey form, and Section 10 sets out the research programme that becomes possible once they are asked.

The argument of this paper is deliberately narrow. Ghana has debated the legitimacy, safety and cultural standing of its traditional medicine for the better part of a century, and that debate has not moved the sector, because legitimacy is not what constrains it. What constrains it is that a majority-provider industry, in a country that counts its cocoa pods and weighs its gold, has never been counted. The forest kept the pharmacy through every decade in which the state pretended it did not exist. The work now is to build the ledger.

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Appendix A. Replication

The estimation is fully reproducible. Every parameter appears in Table 2 with its distribution and bounds, and the simulation uses 200,000 independent draws under a fixed random seed (2026). An accompanying script and workbook reproduce the calculation as live formulas and permit any parameter to be varied, so that a reader who disputes a value can observe its effect on the headline directly rather than in correspondence.

One reconciliation should be stated explicitly, because a reader moving between the paper and the workbook will otherwise find an apparent discrepancy. The workbook computes the deterministic case using the modal value of each parameter and returns final demand of GHS 9.90 billion, or USD 861 million. The paper reports the simulated mean of GHS 11.36 billion, or USD 988 million. The gap of approximately 15% is not an error and is fully accounted for: the mean of a triangular distribution is the average of its three points rather than its mode, and every distribution in the largest layer has an upper bound further from the mode than its lower bound, an effect that compounds when three such parameters are multiplied. The modal case is the single most likely outcome, the simulated mean is the expected value, and the median of GHS 11.13 billion, or USD 968 million, lies between them. Readers preferring the modal case should quote GHS 9.90 billion and will find it fully reproducible in the workbook.

Three further conventions should be noted by anyone reproducing or extending the work. Ratios to gross domestic product are computed in cedi terms against nominal GDP of GHS 1.5 trillion so that the exchange rate convention does not enter them. Dollar conversions use GHS 11.50, the Bank of Ghana interbank mid-rate for July 2026, rather than the implied 2026 period average of GHS 12.68, and users preferring the latter should scale dollar figures by 0.91. And the three aggregates are not interchangeable: gross output double counts intermediates, final demand is the market size, and only value added may be expressed as a share of GDP.

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