

Policy Strategy for Strengthening the Non-Timber Forest Product Value Chain in the Health Cluster of Indonesia's Bioeconomy

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Abstract

The limited value addition of non-timber forest products (NTFPs) in Indonesia's health-related bioeconomy remains a significant challenge, reflected in substantial price disparities between fresh raw materials sold by farmers and dried medicinal plant materials (simplisia) purchased by processing industries. Between 2020 and 2025, the forestry-sector NTFP production base contracted by 20.9%, despite aggregate production figures appearing to double. This study aimed to identify structural constraints and formulate appropriate policy strategies. A qualitative policy research design employed two analytical tracks: prioritizing policy issues using the Urgency, Seriousness, and Growth (USG) method and examining systemic relationships through interviews and focus group discussions. Verbatim transcripts informed a causal loop diagram (CLD) containing 80 variables, 134 causal relationships, and 17 feedback loops. Policy alternatives were subsequently assessed using William N. Dunn's evaluation criteria. The findings revealed 12 reinforcing loops, only two supporting desirable change, and three balancing loops sustaining a low-value equilibrium. Isolated interventions, including seed assistance, financial grants, cooperation agreements, and demonstration plots, proved insufficient to overcome structural constraints. Three strategic leverage points emerged: establishing supply-guarantee institutions, securing downstream investment commitments for regional postharvest processing, and expanding health financing coverage for integrated traditional health services. The study recommends an integrated policy package combining these interventions to strengthen local value addition and address systemic barriers. Collectively, the proposed measures targeted 10 of the 17 identified feedback loops, compared with only two to four loops addressed by individual interventions. This integrated approach offers a more comprehensive pathway toward sustainable NTFP-based bioeconomic development and equitable value distribution.



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INTRODUCTION

Non-timber forest products (NTFPs) constitute an important component of Indonesia's forestry downstream development agenda and provide essential raw materials for the health sector within the national bioeconomy framework. Medicinal plant resources in and around forest areas, processing facilities for dried medicinal plant materials (simplisia), traditional medicine industries, and healthcare facilities collectively form an interconnected value chain.

Research on NTFP commercialization has emphasized that successful commercialization depends not merely on resource availability but also on the establishment of market institutions capable of managing risks and ensuring product quality (Belcher & Schreckenberg, 2007). This perspective aligns with (Bugge Hansen T. & Klitkou, 2016), who conceptualized the bioeconomy not simply as the substitution of conventional materials with biological resources but as an institutional transformation connecting biological production with structured market demand (Elfahmi H. J. & Kayser, 2014; Gereffi Humphrey J. & Sturgeon, 2005; Indonesia, 1999, 2018, 2021).

In Indonesia, the Indonesia Emas 2045 development agenda emphasized increasing the added value of NTFPs as part of national downstream industrialization and bioeconomy development (Indonesia, 2024b). However, despite abundant biological resources and growing demand for herbal products, value addition in producing regions has remained limited. An analysis of provincial NTFP production data by commodity type for 2020–2026 indicated that aggregate production increased by 101.3%, primarily because of contributions from food crops and plantation commodities cultivated within forest areas. In contrast, forestry-specific NTFP production declined by 20.9%, while its share of total reported production decreased from 41.2% to 16.2% (Forestry, 2026; Kaplinsky & Morris, 2001). These findings indicated that the raw material production base supporting forestry-based downstream industries, including the health sector, had contracted despite apparent aggregate growth. This divergence highlighted a structural disconnect between the availability of forest-based biological resources and their integration into domestic health-related value chains.

Field findings indicated that weak supply-chain institutions contributed to limited value addition because production and delivery risks remained concentrated among individual farmers and farmer groups. Discussions with PT Naturindo Fresh in Kulon Progo revealed that farmer groups declined an offer of Rp20,000 per kilogram for dried simplisia, despite the offered price being five times the prevailing market price of Rp4,000 per kilogram. The offer was rejected even after the required supply volume was reduced to five kilograms per quarter because farmers were concerned about their ability to meet contractual commitments. This finding challenged the assumption that higher purchase prices alone would encourage farmer participation in formal supply arrangements. Previous international research on contract farming similarly demonstrated that the benefits received by smallholders depended substantially on the allocation of production risks, contractual obligations, and transaction costs rather than solely on the prices offered (Bellemare & Bloem, 2018; Key & Runsten, 1999).

Meanwhile, discussions with representatives of the Traditional Health Services Functional Unit (Unit Pelayanan Fungsional Pelayanan Kesehatan Tradisional, UPF Yankestrad) at Dr. Sardjito General Hospital and the Hortus Medicus Clinic in Tawangmangu, Karanganyar, highlighted significant constraints at the downstream end of the value chain. The clinic operated an integrated medicinal plant supply and healthcare delivery system, serving approximately 15,000 patient visits by 2025 from various Indonesian provinces. It had also trained approximately 700 physicians and 200–250 pharmacists in herbal medicine. However, patients were required to finance these services independently because the relevant traditional healthcare services and herbal products were not covered by the National Health Insurance (Jaminan Kesehatan Nasional, JKN) scheme. Informants indicated that hospitals participating

in the sister hospital partnership program frequently questioned whether the services were covered by the Social Security Agency for Health (Badan Penyelenggara Jaminan Sosial Kesehatan, BPJS Kesehatan). Consequently, institutional demand for standardized herbal medicines and phytopharmaceutical products remained limited. This constraint was reflected in the reported issuance of marketing authorizations for approximately five phytopharmaceutical products against a target of approximately 25, based on information from the Indonesian Food and Drug Authority's product database (cekbpom.pom.go.id/produk-fitofarmaka).

These conditions highlighted the need for integrated policy interventions that redistributed supply-chain risks away from individual farming households, encouraged postharvest processing and value retention in producing regions, and strengthened institutional demand for standardized herbal products. Such interventions could improve household incomes in forest-dependent communities while supporting the development of domestic medicinal plant supply chains and reducing dependence on externally sourced raw materials.

Based on preliminary evidence and field investigations, six potential policy problems were identified and assessed by expert respondents using the (Haq et al., 2026; Vennix, 1996; Williamson, 1979), Seriousness, and Growth (USG) method (Table 1). Supporting evidence indicated that farmers received approximately Rp500 per kilogram for fresh rhizomes, whereas dried *simplicia* was sold for approximately Rp4,000 per kilogram in local markets and Rp20,000 per kilogram to industrial buyers, with an estimated 80% reduction in weight during drying. Forestry-specific NTFP production declined from 215,564 tons to 170,513 tons between 2020 and 2025 (Ministry of Forestry, 2026). Furthermore, 47.6% of the 1,403 provincial commodity-type-year observations recorded production activity during only one to three months annually. Processing industries obtained 75 of 82 raw material types through intermediaries, with inconsistent moisture content and product specifications. Although approximately 700 physicians and 200–250 pharmacists had received herbal medicine training, this capacity had not been widely translated into traditional healthcare services across other facilities. In addition, approximately five phytopharmaceutical products had reportedly obtained marketing authorization against a target of approximately 23. Raw material quality assessments also continued to emphasize production volume rather than the concentration of bioactive compounds (Verbatim KPH Yogyakarta, PT Naturindo Fresh, and UPF Yankestrad RSUP Dr. Sardjito, 2026).

The assessment employed the USG method using a five-point rating scale administered through an online questionnaire. The instrument also included open-ended questions addressing additional policy problems, overlaps among proposed issues, and respondents' confidence in their assessments. Three respondents participated, comprising two representatives from the processing industry and one representative from a healthcare service institution.

The assessment results ranked candidate 2, concerning limited capacity among forestry stakeholders and restricted access to markets, investment, and technology, and candidate 6, concerning inconsistent quality and specifications of herbal products, as the highest priorities. Both candidates received total scores of 36, with an average score of 12.0. They were followed by candidate 5 (35), candidate 3 (34), candidate 4 (33), and candidate 1 (28). However, the two highest-ranked candidates also exhibited the greatest variation in respondent assessments, with

score ranges of 9–14 and 9–15, respectively. In contrast, candidates 3 and 5 showed greater agreement, with score differences of only one point. These differences reflected respondents' positions within the value chain. Industry representatives assigned candidate 2 scores of 14 and 13, whereas the healthcare representative assigned it a score of 9. An opposing pattern emerged for candidate 6, indicating that respondents prioritized problems according to their respective institutional responsibilities and operational experiences.

Despite these differences, the assessment revealed that the two highest-ranked problems were structurally interconnected. Inconsistent raw material quality resulted partly from inadequate postharvest processing capacity and the limited communication of quality-testing results to producers. Meanwhile, insufficient postharvest capacity was associated with low farmgate prices and the absence of reliable supply partnerships. These relationships suggested that the two problems shared underlying structural causes rather than representing independent policy priorities. A systems thinking approach was therefore considered appropriate for examining their interdependence and identifying interventions capable of addressing multiple constraints simultaneously.

Nevertheless, the assessment findings remained preliminary because two of the three respondents represented the same company, while upstream producers and government institutions were not represented. Respondents reported confidence levels of 3, 3, and 4 on a five-point scale, and the first respondent assigned identical scores to five candidates. The third respondent also proposed an additional issue concerning clinical trials of herbal medicines, particularly the evidence requirements for advancing traditional herbal products into standardized herbal medicines (*Obat Herbal Terstandar*, OHT) and phytopharmaceuticals (*fitofarmaka*). However, the potential contribution of this issue to value addition within the forestry-based medicinal plant supply chain had not yet been established.

Candidates 2 and 6 were subsequently selected as provisional priority problems for further investigation. Their underlying causes were examined through successive levels of causal analysis, progressing from immediate constraints to intermediate factors and structural root causes. These relationships were then incorporated into causal loop diagrams (CLDs) to identify feedback mechanisms that reinforced the persistence of low value addition.

The feedback loop analysis indicated that the identified second-level causes converged on a common structural constraint, designated as variable 1a1: the concentration of supply default risk and market risk among stakeholders with the least capacity to absorb them. Factors 1b–1e were not independent causes but interconnected consequences that reinforced factor 1a through reinforcing feedback loop R1. Accordingly, the principal causal pathway extended from variable 1a1 to variable 1a and subsequently to the central problem of limited value addition within the NTFP health-sector value chain.

Supply default risk and market risk within the health-related NTFP value chain were disproportionately borne by individual farming households and forest farmer groups. This unequal distribution of risk discouraged the establishment of reliable supply partnerships, even when industrial buyers offered purchase prices substantially above prevailing market rates. Consequently, investment in postharvest processing facilities remained limited in producing regions, resulting in inconsistent raw material quality and bioactive compound concentrations.

NTFPs therefore continued to be marketed primarily as low-value fresh materials, while much of the downstream economic value was captured outside the producing communities.

This study aimed to identify priority constraints and their root causes within the health-related NTFP value chain, examine systemic relationships through CLDs to identify feedback mechanisms sustaining low value addition, determine strategic policy leverage points, and formulate an integrated evidence-based policy package. The proposed interventions were evaluated using the policy criteria of effectiveness, efficiency, adequacy, equity, responsiveness, and feasibility, with particular attention to implementation sequencing and institutional responsibilities. The findings were expected to inform policy development by the Ministry of National Development Planning/National Development Planning Agency (Badan Perencanaan Pembangunan Nasional, Bappenas), the Ministry of Forestry, and the Ministry of Health. They were also intended to guide forest management institutions in strengthening supply aggregation and postharvest investment, support businesses in developing more reliable partnership arrangements, improve value retention among forest-dependent communities, and strengthen domestic supply chains for medicinal plant raw materials used in Indonesia's healthcare system.

RESEARCH METHOD

This study employed a qualitative policy analysis approach to identify key challenges, examine their underlying causes, and formulate policy alternatives for strengthening the non-timber forest product (NTFP) value chain in Indonesia's health sector. The study focused on medicinal plant-based NTFP value chains, particularly supply-chain partnerships, institutional arrangements, postharvest processing capacity, quality standards, and financing mechanisms influencing downstream demand.

Primary data were collected through in-depth interviews and focus group discussions with representatives of three institutions occupying different positions within the value chain: KPH Yogyakarta (upstream forest management institution), PT Naturindo Fresh in Kulon Progo (processing industry), and the Traditional Health Services Functional Unit (UPF) of Dr. Sardjito Hospital and Hortus Medicus Clinic in Tawangmangu (healthcare service providers). The discussions were recorded and transcribed verbatim. Secondary data included NTFP production records by commodity type and province from January 2020 to July 2026, covering 36 provinces and 139 commodity types, obtained from the Ministry of Forestry's One PHL Data platform, along with relevant regulatory documents and scientific literature. The analytical process followed the framework presented in Figure 2, in which preliminary data were examined through two parallel analytical pathways that were subsequently integrated during the policy formulation stage.

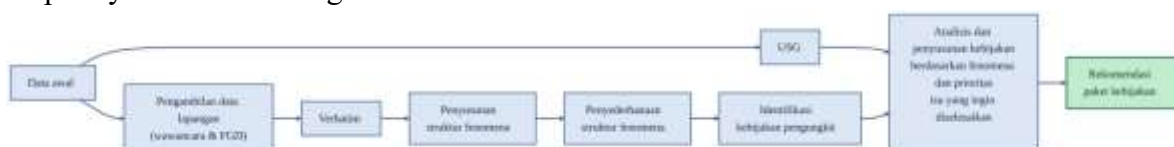


Figure 1. Study framework

Source: Researcher's own construction (2026).

Stage 1: Preliminary Data Collection. Secondary data, policy documents, and scientific literature were reviewed to identify potential policy problems and establish the focus of subsequent field investigations.

Stage 2a: Urgency, Seriousness, and Growth (USG) Assessment. Six potential policy problems were assessed by expert respondents using a five-point scale based on urgency, seriousness, and the potential for further deterioration. The assessment initially targeted three to five respondents representing upstream producers, downstream industries, healthcare providers, and government institutions.

Stage 2b: Field Data Collection. In-depth interviews and focus group discussions were conducted to investigate the underlying factors contributing to the persistence of identified problems.

Stage 3: Verbatim Transcription. Interview and discussion recordings were transcribed verbatim to ensure that variable identification and interpretation remained grounded in participants' statements.

Stage 4: System Structure Development. The transcripts were coded to identify variables, causal relationships, and their directional polarities. Positive (+) polarity indicated changes occurring in the same direction, whereas negative (−) polarity indicated changes occurring in opposite directions. Connecting variables were explicitly identified to clarify relationships within the causal structure.

Stage 5: Causal Loop Simplification. Causal relationships that did not form closed feedback loops were excluded from the simplified causal loop diagram. The remaining loops were classified as reinforcing or balancing feedback loops, and their implications for system behavior were examined to identify potential unintended consequences of isolated policy interventions.

Stage 6: Identification of Policy Leverage Points. Potential policy leverage points were identified by examining the number and characteristics of feedback loops influenced by each variable, drawing on the systems thinking framework proposed by (Meadows, 1999). This approach emphasized structural influence rather than relying exclusively on budgetary considerations.

Stage 7: Policy Formulation. Policy alternatives were developed by integrating the prioritized problems identified through the USG assessment with the leverage points derived from the causal loop analysis. The alternatives were subsequently evaluated using Dunn's (2018) policy evaluation criteria: effectiveness, efficiency, adequacy, equity, responsiveness, and feasibility.

Stage 8: Integrated Policy Package Recommendations. The evaluation results were used to determine policy entry points, implementation sequences, and institutional responsibilities rather than to eliminate individual alternatives. All identified causal relationships were treated as provisional hypotheses derived from participants' accounts and qualitative interpretation rather than statistically validated causal effects.

RESULTS AND DISCUSSION

The Magnitude of the NTFP Supply Problem

The main problem identified is the lack of post-harvest added value in the NTFP-producing areas of the health cluster. The magnitude of the problem is shown by the national production data, which is the basis for measuring several variables in the diagram.

The only NTFP with an established downstream industry, namely pine sap with an average of 10.1 months of activity per year, is also the only commodity whose supply is close to continuous. This indicates that continuity of supply is the result of the formation of absorption institutions, not prerequisites that must be met first.

Structuring and Simplifying the Structure of Phenomena

All of the speakers' statements in verbatim were rearranged into a causal loop diagram containing 80 variables in eight segments, namely regions and farmer groups, drying and quality, collectors and aggregators, trust and contracts, industry, markets and consumers, budget and data, and health services and regulations, which were connected by 134 cause-and-effect arrows and formed 17 feedback circles. The five variables marked $\oplus$ are connecting variables that are not pronounced as terms by the speakers but are necessary for the cause-and-effect chain to be connected into a circle, and the fifth is marked so that it can be checked at the validation stage. The complete diagram is presented in Figure 3.

The whole structure is then simplified by setting aside arrows that do not form closed chains, thus shrinking to 45 variables and 80 arrows that form 17 circles without losing the mechanism that explains the behavior of the system. The circle map is presented in Figure 4 and the complete list in Table 4.

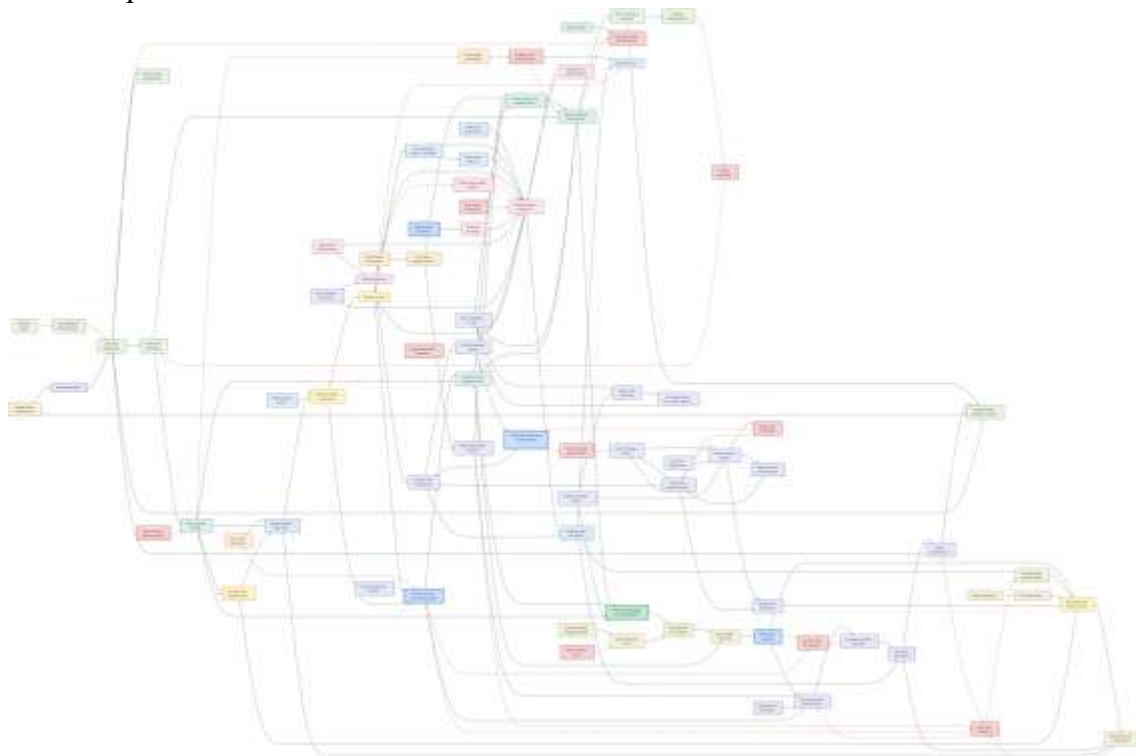


Figure 2. Causal Loop Upstream –downstream value chain diagram of the health cluster

Source: Researcher's own construction (2026).

NTPF, the structure of the phenomenon is intact (80 variables, 134 arrows). The whole line indicates a unidirectional relationship (+), the dotted red line indicates the opposite relationship (-). The thick blue box is the policy leverage point, the thick green box is the downstream goal variable, and the red box is the inhibiting variable.

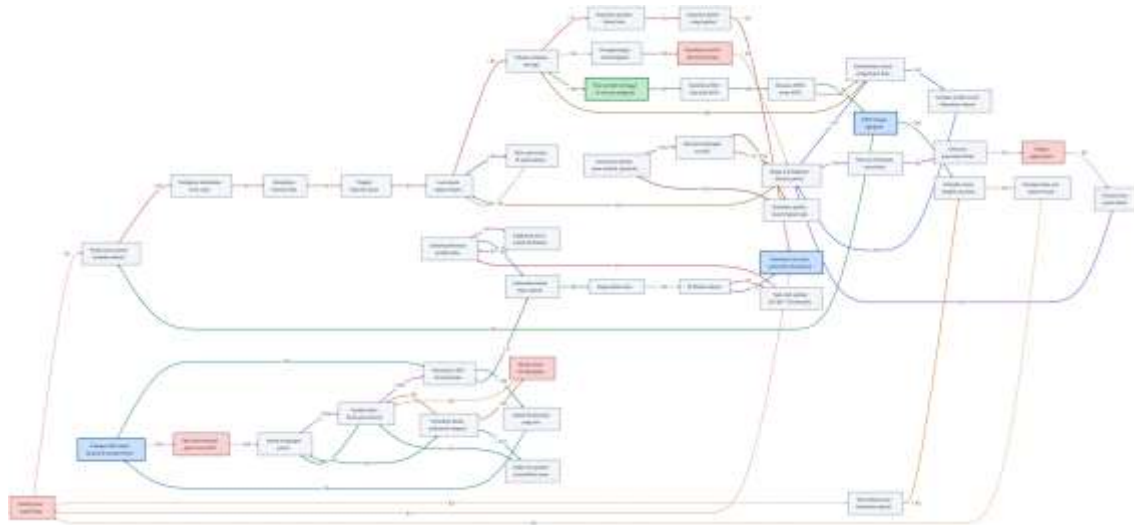


Figure 3. Map of 17 feedback circles, simplified phenomenon structure (45 variables, 80 arrows). Each arrow color represents a circle, with a polarity label and circle code on each arrow.

Source: Processed from verbatim interview and FGD data with KPH Yogyakarta, PT Naturindo Fresh Kulon Progo, and UPF Yankestrad RSUP Dr.

Table 1. Seventeen feedback circles

Code	Circle name	Properties	Segments
R1	The trap of distrust	Strengthening, worsening	Contracts, upstream, industry
R2	Upstream–downstream time inconsistency	Strengthening, worsening	Data and planning
R3	Low-value traps	Strengthening, worsening	Drying, quality, price
R4	Dominance of collectors	Strengthening, worsening	Aggregation
R5	Erosion of peasant groups	Strengthening, worsening	Hulu
R6	Trusted aggregator	Strengthen, IMPROVE	Institutional and fiscal
R7	Downstream market formation	Strengthening, two-way	Markets
R8	FMU's fiscal pitfalls	Strengthening, worsening	Budget
B1	Maintenance workforce limits	Counterbalances	Hulu
B2	Industrial margin clamps	Counterbalances	Industry and market
J	Bridge market margins to upstream investments	Connectors	Industry and contracts
R9	JKN's trap on phytopharmaceuticals	Strengthening, worsening	Healthcare
R10	Free remedies beat paid herbs	Strengthening, worsening	Healthcare
B3	Risk of claims withholding health facilities	Counterbalances	Healthcare
R11	Doubling of services through training	Strengthen, IMPROVE	Healthcare
R12	Quality feedback of active substances	Strengthening, improving when run	End

Code	Circle name	Properties	Segments
J2	Bridge the demand for health facilities to upstream raw materials	Connectors	Health and upstream

Source: Processed from verbatim interview and FGD data with KPH Yogyakarta, PT Naturindo Fresh Kulon Progo, and UPF Yankestrad RSUP Dr. Sardjito Tawangmangu (2026); analyzed using causal loop diagram method (Kim & Andersen, 2012; Newberry & Carhart, 2024).

This structural diagnosis is the study's most important finding. Of the 17 circles, 12 were reinforcing and only two moved in the desired direction, namely R6 and R11, while the three balancing circles (B1 wage costs limiting planting area, B2 industrial margins eroded, and B3 risk of claims holding back health facilities) balanced the system in an undesirable direction. Such a system runs itself towards a low-value equilibrium (Sterman, 2000), which explains why seed aids, grants, memorandums, and plot demonstrations repeatedly fail: each only touches one arrow while the circle remains intact.

Feedback Circles That Determine Issues

Twelve of the seventeen circles are directly related to the main issue and are described one by one in this section along with the ring drawings. The remaining five circles, namely R7, B1, B2, J, and J2, are not drawn separately because they are in market and connecting segments that are not the focus of the recommendations, but are still listed in Table 4 and Figure 3.

R1: The trap of distrust

The increase in the lost market during harvest decreases farmers' confidence in the industry, the desire to cooperate, and the number of contracts; contracts that slightly reduce market certainty, empon-empon planting area, simplification volume, certainty of supply and factory utilization, so that downstream investment commitments in suppliers do not enter and the lost market increases. This circle explains the rejection of the price of Rp20,000 to the market price of Rp4,000, because what circulates in the system is not price but risk; according to Meadows' hierarchy (1999), changes in risk-sharing rules have much higher leverage than changes in price parameters.

R2: Upstream–downstream time inconsistency

The availability of data on industrial needs increases the chances of a rotating planting calendar, upstream readiness when the industry needs it, and reduces the market lost during harvest. This circle explains the complaints on both sides of the chain: when the industry needs, the upstream has not yet planted, and when the upstream harvest, the industry needs a continuous supply. The intervention can be fulfilled by the government, because the annual needs data is already owned by the industry and what is not yet available is the channel upstream.



Figure 4. Circle R1, the trap of distrust

Source: Processed from causal loop diagram simplification (2026). Each arrow color represents a circle, with polarity label and circle code on each arrow.



Figure 5. Circle R2, upstream–downstream time incontinence

Source: Processed from verbatim interview and FGD data (2026).

R3: Low-value traps

The availability of drying houses upstream increases product quality, farmers' prices and income, as well as the ability to invest in dryers. Currently, the circle rotates in the opposite direction, so that the price difference of four to five times lasts for years without anyone filling it, and any increase in volume without post-harvest capacity only increases the volume of wet materials worth Rp500 per kilogram.

R4: Collector dominance

The decline in the volume of simplicia supplied directly increases dependence on collectors and stock holding practices and price games, lowers farmers' prices and planting area, and again decreases the volume of simplicia. Cutting off collectors directly will eliminate their jobs; what is needed is a coaching aggregator who runs quality assurance in stages with managed transitions.

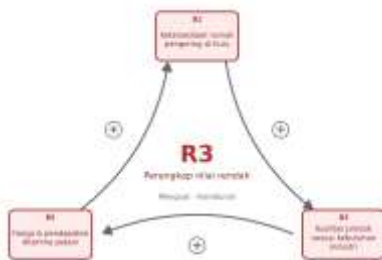


Figure 6. R3 circle, low-value trap

Source: Processed from verbatim interview and FGD data (2026).

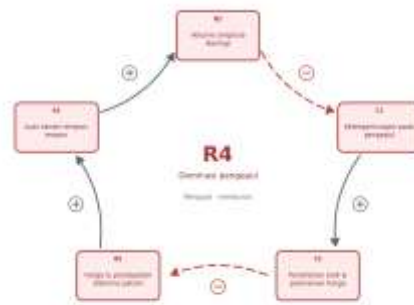


Figure 7. Circle R4, the dominance of collectors

Source: Processed from verbatim interview and FGD data (2026).

R5: Erosion of farmer groups

Group motivation increases the intensity of garden care, decreases crop failure, increases harvest volume and income, which in turn increases motivation. In the field, this circle revolves in reverse: the case of gotu gotu in Samigaluh shows that grants, college mentoring, and memorandum of understanding are not able to withstand the round because the maintenance picket schedule does not run while new results are received after eight months. In line with (Ostrom, 1990), group failure stems from incentive design, not lack of funds.

R6: Trusted aggregators

The presence of FMUs as aggregators increases farmer confidence, cooperation, contracts, market certainty, planting area, simplicia volume, and added value in producing areas, which increases the PAD and APBD for FMUs so that aggregator capacity is strengthened again. This is one of two circles that move in the desired direction, relying on the trust of the fostered group and operational costs without collateral. However, FMUs cooperation with the processing industry does not yet exist so that this flow is interrupted in the field, and on a national scale, it is necessary to encourage aggregators who are able to carry out similar roles.



Figure 8. Circle R5, erosion of farmer groups

Source: Processed from verbatim interview and FGD data (2026).



Figure 9. Circle R6, a trusted aggregator

Source: Processed from verbatim interview and FGD data (2026).

R8: FMU's fiscal traps

The amount of the APBD for FMUs increases the availability of drying houses, the volume of simplicia, added value, and PAD, which in turn increases the APBD. Because it rotates the other way around, this circle explains why the investment capacity of regional managers does not grow: the budget is determined by the region and not by market opportunities, so that the low revenue of one year reduces the investment capacity of the following year.

R9: JKN Trap on Phytopharmaceuticals

The coverage of JKN for herbal services and products increases the demand for OHT and phytopharmaceuticals, the number of phytopharmaceuticals released, and the basis for dependents. Currently, the circle is reversed: because it has not yet been covered and the JKN formulary, demand has not been formed, the industry does not produce even though development costs have been incurred, and the basis for coverage remains thin.

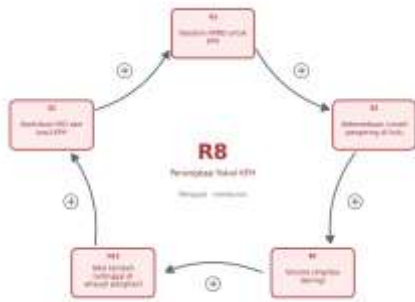


Figure 10. Circle R8, FMU's fiscal trap
Source: Processed from verbatim interview and FGD data (2026).

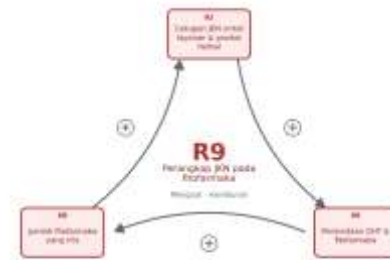


Figure 11. Circle R9, JKN trap on phytopharmaceuticals
Source: Processed from verbatim interview and FGD data (2026).

R10: Free medicine beats paid herbs

The availability of conventional medicines at no cost through JKN has reduced visits to herbal services, the number of facilities that run traditional health services, the demand for OHT and phytopharmaceuticals, and the opportunity for dependents. The problem is not the low interest of the public, but paid services that are directly related to free alternatives.

B3: Risk of claims withholding health facilities

The presence of traditional health service clinics integrated with paid services increases the risk of hospital claims being canceled, so that other facilities are reluctant to open similar services and the presence of similar clinics decreases. This balancing act can only be mitigated by the clarity of dependents and crowdfunding limits, without direct fiscal costs; the process of revising the regulation of herbal medicines for admission to JKN that is being proposed is expected to eliminate it.



Figure 12. Circle R10, a free remedy beats paid herbs
Source: Processed from verbatim interview and FGD data (2026).

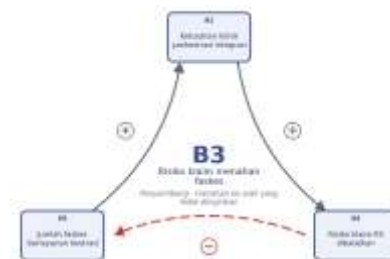


Figure 13. Circle B3, the risk of claims to withhold health facilities
Source: Processed from verbatim interview and FGD data (2026).

R11: Duplication of services through training

The presence of clinics increases the number of herba-certified doctors and pharmacists, facilities that run traditional health services, and patient visits, which underpins the next clinic. This is the second circle that is moving in the desired direction; the machine is already running with about 700 doctors, 250 pharmacists, and a network of sister hospitals, but it is held back by B3 and R10.

R12: Quality feedback of active substances

Habitat suitability, growing life, and agronomy increase active ingredient content, quality control benefits, and agronomic improvements in the following season. This circle does not rotate because the test results stop in the laboratory; connecting them is a low-cost intervention that directly affects farmers' prices and corrects the assumption that success is measured by tonnage.



Figure 14. Circle R11, duplication of services through training

Source: Processed from verbatim interview and FGD data (2026).

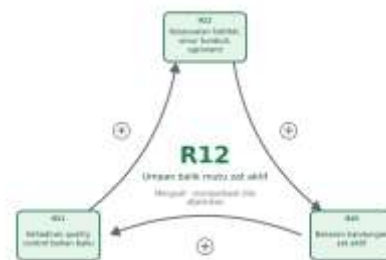


Figure 15. Circle R12, quality feedback of active substances

Source: Processed from verbatim interview and FGD data (2026).

Identify Leverage Policies

Following the principle of leverage points, intervention points are ranked based on the number and nature of the feedback loops that a variable can touch, to see which points when intervened have a wide impact on the entire set of systems (Table 5).

Table 2. Policy leverage points by number of circles touched

Ratings	Leverage points	Circles touched	Available policy tools
1	H2: JKN/BPJS coverage for herbal services and products	R9, R10, B3, as well as indirectly releasing R11 (four circles)	Health financing regulations; are beyond the authority of the forestry sector
2	C3: FMU or cooperative as guarantor aggregator	R1, R2, R6 (three circles)	RKU approval; regional utilization cooperation agreement
3	B1 and H10: drying near the source with the active substance as the basis of the price	R3, R4, R12 (three circles)	Post-harvest facility financing; contract quality standards

Ratings	Leverage points	Circles touched	Available policy tools
4	D10: downstream partners' investment commitments in the upstream	R1, R3 (two circles)	Mandatory clauses in supply contracts; fiscal incentives
5	H4 and H5: training and sister hospitals	R11 (one circle, capacity readily available)	Permenkes 003/2010 that is already running
6	G3 and H16: data on the needs of industries and health facilities	R2 (one circle, cheapest intervention)	Annual needs plan reporting obligations

Source: Processed from causal loop diagram analysis of verbatim interview and FGD data (2026), following Meadows' (1999) leverage point framework.

The location of the strongest levers shifts as the actors interviewed increase: before the discussion with UPF Hortus Medicus the top lever is the guarantor aggregator (three circles), while after that it moves to the scope of health financing (four circles). This shows that the conclusions of the study are sensitive to the addition of actors, and that the strongest levers are beyond the authority of the forestry sector.

Policy Determination: Ultrasound Synthesis and Leverage Points

At this stage the two paths meet: the ultrasound establishes the issues that must be answered first, while the phenomenon structure establishes at what point the policy must work for the change to last. The production data shows what happens, while the circular structure explains why it persists, i.e. because the party that is asked to commit first is the party with the least ability to bear the risk (Table 6).

Table 3. Synthesis of diagnosis and its derivatives as policy alternatives

Data findings	A circle that explains	Leverage points	Policy alternatives
The median is four months active per year, and only pine sap with established downstream industries is in continuous supply	R1, R2, R6	C3	Alternative 1
As many as 72.2% of the provincial-type pairs produce below 100 tonnes per year with a contribution of 0.6% of volume, while the difference in wet prices to simplicia reaches four to five times	R3, R4, R12	B1/H10 and D10	Alternative 2
The forest NTFP base shrank by 20.9% despite an increase of 101.3% in aggregate, and final demand did not form	R9, R10, B3, R11	H2	Alternative 3
Honey was recorded at 23.36 tons for six years, so that the community's NTFPs were not on the planning radar	R2	G3/H16	Adhering to the three alternatives as a prerequisite for implementation

Source: Processed from Ministry of Forestry (2026) NTFP production data, causal loop diagram analysis, and verbatim interview and FGD data (2026).

Related Regulatory Analysis

The legal basis for the policy package is largely available. **Law No. 41 of 1999 on Forestry** (Indonesia, 1999) emphasizes that the use of forests, including NTFPs, must provide the greatest benefits for the welfare of the people in a sustainable manner. **Law No. 17 of 2023 on Health** (Indonesia, 2023) and **Government Regulation No. 28 of 2024** articles 479, 925, and 926 (Indonesia, 2024a) place traditional health services and natural medicines within the framework of national pharmaceutical independence. **Permenkes No. 37 of 2017** (Ministry of Health, 2017) is the basis for traditional health services to be integrated and replicated through sister hospitals, so that the legal basis for services is available while the financing basis is not yet available; this regulation opens the R11 route but has not eliminated B3. **Permenkes No. 003/Menkes/Per/I/2010 concerning Herbal Medicine Scientification** (Ministry of Health, 2010) produces a competency base for trained personnel who have not been converted into services, while Presidential Regulation No. 82 of 2018 (Indonesia, 2018) is a reference for regulating health insurance dependents.

In the forestry sector, **Government Regulation No. 23 of 2021** (Indonesia, 2021a) and **Minister of Environment and Forestry Regulation No. 8 of 2021** (Indonesia, 2021b) regulate forest utilization licensing and the preparation of Business Work Plans (RKU), so that the role of aggregators and post-harvest investment obligations can be attached to the approval of RKU without new legal instruments. **Government Regulation No. 28 of 2025** (Indonesia, 2025) is the basis for the ongoing revision of the Minister of Environment and Forestry Regulation No. 8 of 2021, so it is a limited-time policy window to include arrangements for NTFP supply partnerships, post-harvest investment, and aggregator institutions.

Policy Alternatives and Their Evaluation

Three policy alternatives are derived directly from the top three leverage points in Table 5. **Alternative 1** establishes the institution of the aggregator for the guarantee of NTFP guarantees for the health cluster through a supply contract with a harvest cycle horizon attached to the approval of the RKU and the regional utilization cooperation agreement (leverage point C3, breaking R1 and R2 and moving R6). FMUs, cooperatives, or village-owned enterprises are designated as guarantor aggregators that bear the risks of quantity and quality, with the arrangement of phased contracts that are not fully binding in the first year, tiered quality assurance, submission of annual needs plans as the basis for a rotating planting calendar, and responsibility sharing between aggregators, farmer groups, and downstream partners.

Alternative 2 establishes post-harvest investment obligations in producing areas for downstream partners, accompanied by active substance content as the basis for quality and contract prices (leverage B1/H10 and D10, cutting R3 and R4 and turning on R12). Because the drying capacity is not owned by area managers, farmers, or industries, every NTFP utilization cooperation agreement is accompanied by communal drying houses, warehouses, and post-harvest training, following precedents in several large herbal medicine industries, as well as the obligation to return quality test results to growers.

Alternative 3 gradually opens up health financing coverage for traditional health services integrated into accredited facilities, accompanied by clarity on crowdfunding rules (leverage H2, driving R9, reducing R10, eliminating B3, and releasing R11). The stages start from coverage of actions and consultations before the product, with closed trials at facilities where

competencies are available given that approximately 950 health workers have been trained. The leverage is highest, but the authority is outside the forestry sector.

The three alternatives were evaluated with the criteria of (Cassidy Borghi J. Semwanga A. R. Binyaruka P. Singh N. S. & Blanchet, 2022; Dunn, 2018), namely effectiveness, efficiency, adequacy, equity, responsiveness, and political feasibility, which can be adapted into a scoring system according to the institutional context. The number of circles touched is used as the basis for assessing adequateness, while the location of authority is the basis for assessing feasibility (Table 7).

Table 4. Analysis of policy alternatives based on William N. Dunn's criteria

Yes	Policy Alternatives	Broken circles	Effects	Efficiency	Cuckle	Averaging	Response	Casual	Total Score
1	The institution of the guarantor aggregator through a supply contract with a harvest cycle horizon, is attached to the approval of the RKU	R1, R2, R6	5	4	4	5	4	5	27
2	Post-harvest investment obligations in producing areas for downstream partners, with quality based on active substance content	R3, R4, R12	4	5	3	4	3	4	23
3	Gradual opening of health financing dependents for yankestrad integration, accompanied by clarity of crowdfunding	R9, R10, B3, R11	5	3	5	4	5	4	26

Source: Processed from policy alternative evaluation using Dunn's (2018) criteria: effectiveness, efficiency, adequacy, equity, responsiveness, and feasibility.

Alternative 1 obtained the highest total score of 27, so it is considered the most comprehensive in addressing the root of the problem while being within the authority of the forestry sector with high implementation feasibility. Alternative 3 obtained the highest adequacy and responsiveness score because it touches four circles, but is held back to political feasibility because it cannot be implemented in terms of regulations; at the time of writing this study, the revision process of PP 28/2024 is underway which can be the entry point, and based

on a separate FGD, BPOM as part of the Phytopharmaceutical Task Force is fighting for natural ingredients to be included in the JKN formulary.

The output of this stage is not a single alternative but a single policy package, as the three alternatives break different circles and do not replace each other. Alternative 1 works on the upstream side, Alternative 2 on the post-harvest stage, and Alternative 3 on the demand side. Of the 17 circles, all three together touch ten, while each alone touches only two to four. Running just one means leaving the rest intact, and an intact circle will reabsorb the improvements that have been achieved. The arrangement of the packages and the order in which they are implemented are presented in Table 8.

Table 5. Proposed arrangement of policy packages and order of implementation according to Dunn's priorities

Components	Roles in the package	Main authorities	Horizon
Alternative 1: guarantor aggregator institution	Entrance. Obtain the highest score and already have a regulatory basis so that it can be carried out without waiting for other parties	Ministry of Forestry, through the approval of the RKU and the area utilization cooperation agreement	Short-term
Alternative 3: gradual opening of health financing dependents	Market opener. It has the greatest leverage, but requires a cross-sector process so that it is taken in parallel, including efforts to be included in the revision of PP 28/2024	Ministry of Health and BPJS Kesehatan, with the Ministry of National Development Planning/Bappenas as the coordination node	Short-medium term
Alternative 2: post-harvest investment obligations and quality based active substances	Complements attached to the first component. Without post-harvest capacity, the contract formed still leads to low-value wet materials	The Ministry of Forestry together with local governments and financing institutions	Medium term
Implementation prerequisites: data systems for industrial needs and health facilities	Inherent to all three components. The cheapest intervention, but without it the planting calendar cannot be compiled and the time irregularities remain repetitive	The Ministry of Forestry together with the Ministry of Health and industry associations	An enabler that accelerates supply chain flow

Source: Processed from policy alternative evaluation results and institutional authority mapping (2026).

Study Limitations

This study has several limitations: the price, scope, and number of trained personnel are sourced from the oral statements of the sources that have not been verified by official documents; each cause-and-effect relationship is still in the status of an alleged work and four determinant relationships must be tested; five connecting variables need to be validated; cases come from the Special Regions of Yogyakarta and Central Java so that national generalization requires comparative cases on non-special FMUs; the ultrasound assessment was only filled by three respondents and alternative scoring has not gone through an expert panel; and the scope is limited to NTFPs of medicinal plants.

Novelties and Contributions

The novelty of this study lies in the placement of the value chain of NTFP in the health cluster as a feedback system that extends to the state health financing system, with a causal

loop diagram compiled from the words of the speakers, measured with national production data, and ended with the evaluation of the Dunn criteria. Empirically, this study shows that the growth of national NTFP production is pseudo, that price incentives are ineffective without changes in risk allocation, and that only two of the 17 circles move in the desired direction, so the success of downstream needs to be measured by the portion of added value in the producing area and the content of active substances, not the volume of production.

CONCLUSION

The study concluded that the primary challenge in strengthening the non-timber forest product (NTFP) value chain within Indonesia's health-related bioeconomy was not the limited availability of biological resources or insufficient price incentives but rather weaknesses in value chain governance that disproportionately placed supply default risk and market risk on smallholder farming households with limited risk-bearing capacity. The reported 101.3% increase in aggregate NTFP production masked a 20.9% contraction in forestry-specific NTFP production, while the supply chain remained fragmented, with a median of only four months of production activity annually. The causal loop analysis identified 17 feedback loops, including 12 reinforcing loops, only two of which supported the desired direction of change, and three balancing loops that maintained the system in a low-value equilibrium. These structural constraints helped explain why isolated policy interventions had been insufficient to achieve sustainable value addition. Accordingly, the study recommended that the Ministry of National Development Planning/National Development Planning Agency (Bappenas) coordinate an integrated, cross-sectoral policy package comprising three components.

First, supply-guarantee institutions should be established through designated aggregators and supply contracts aligned with harvesting cycles and incorporated into approved business work plans and forest-area utilization agreements. Second, downstream industry partners should be required to invest in postharvest processing facilities within producing regions, adopt bioactive compound content as a basis for quality assessment and contract pricing, and communicate laboratory testing results to growers. Third, financing coverage for integrated traditional healthcare services should be expanded gradually, alongside clearer regulations governing crowdfunding mechanisms. Together, these interventions addressed 10 of the 17 identified feedback loops, compared with only two to four loops addressed by each intervention individually. An integrated information system documenting the annual raw material requirements of processing industries and healthcare facilities was also recommended to support production planning and the development of coordinated planting calendars. Future research should empirically examine four key hypothesized causal relationships, validate problem prioritization and policy alternative scoring through broader expert panels, and incorporate comparative cases beyond the Special Region of Yogyakarta and Central Java to assess the applicability of the proposed policy framework across different regional contexts.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of the research, preparation, or publication of this article.

AUTHOR CONTRIBUTIONS

All authors contributed to the preparation of this article. The first author, Adi Misda Indarto, was responsible for the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation. The other authors contributed to the review, editing, and final approval of the manuscript.

GENERATIVE AI STATEMENT

The authors declare that no generative artificial intelligence was used in the preparation of this article.

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