



Pesantren Living Pharmacy Management Model: Cultivation of Family Medicinal Plants (TOGA) as a Response to the Global Drug Availability Crisis

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ABSTRACT:

Background: The global drug availability crisis has become increasingly tangible since early 2025, with unprecedented tariffs on pharmaceutical imports, supply chain disruptions, and over 100 medicines in short supply worldwide. Approximately two billion people globally lack access to essential medicines. Islamic boarding schools (pesantren) in Indonesia face significant vulnerability to this crisis, yet possess traditional knowledge and available land that can be optimized through Family Medicinal Plants (TOGA) cultivation as a living pharmacy. Objective: This study aims to develop a management model for pesantren living pharmacy through TOGA cultivation as a strategic response to the global drug shortage crisis. Method: This qualitative study employs a grounded theory approach. Data were collected through in-depth interviews, participant observation, and document analysis involving pesantren administrators, santri, TOGA cultivation managers, and health practitioners in selected pesantren in [location]. Data analysis followed the Corbin and Strauss (2015) grounded theory procedure. Findings: The study identified three core categories: (1) the urgency of pesantren health independence amid global drug shortages, (2) the integration of TOGA cultivation into pesantren management systems, and (3) a four-phase living pharmacy management model encompassing planning, cultivation, processing, and utilization. Conclusion: A substantive theory of Pesantren-Based Living Pharmacy Management is proposed, offering a strategic framework for building health self-sufficiency in pesantren communities as a response to global pharmaceutical supply vulnerabilities.

Keywords: Living Pharmacy, Family Medicinal Plants (TOGA), Pesantren Management, Drug Shortage Crisis, Health Independence, Herbal Medicine

INTRODUCTION

The global pharmaceutical supply chain has become increasingly fragile under the combined pressure of pandemics, war, political conflict, export controls, climate-related disruption, and logistical bottlenecks, and this fragility has turned medicine access into a structural governance problem rather than a temporary operational failure (Sarkar, 2025). COVID-19 made these weaknesses visible at scale by exposing how border closures, lockdowns, port delays, reduced flights, and constrained cargo space could rapidly interrupt the movement of essential medicines and medical supplies across countries (Fadojutimi, 2024). A major underlying cause is the geographic concentration of active pharmaceutical ingredient production in a small number of countries, because this creates upstream single points of failure that can propagate through downstream manufacturing and distribution networks. The concentration is especially pronounced around China, which holds an estimated 40% of global API production, while India sources almost 70% of its APIs from China, showing how even large generic producers can remain dependent on one dominant upstream supplier base (Årdal et al., 2021). Recent U.S.-focused analysis reaches the same conclusion from a national security angle, reporting that over 80% of APIs are manufactured outside the United States, with substantial concentration in China and India, which creates dependency risks that are strategic as well as commercial (Gupta & Gupta, 2025).



Comparative modeling of global pharmaceutical supply chains further shows that geopolitical strain is not an abstract risk but a quantifiable access problem, because baseline expected global shortages in one model reached 17.2%, with a striking inequality across income groups: 0.3% in high-income countries, 0.8% in upper-middle-income countries, 87.2% in lower-middle-income countries, and 87.6% in low-income countries (Pava & Tucker, 2023). That result suggests that the burden of shortages falls disproportionately on poorer settings, so a global disruption that appears manageable in wealthy countries can become catastrophic in import-dependent health systems with weaker bargaining power and thinner inventories (Luis et al., 2025). Evidence from broader reviews agrees that medicine shortages are a persistent and multifactorial public health challenge rather than an isolated crisis event, with structural, economic, and regulatory vulnerabilities reinforcing one another over time (Acosta et al., 2019). Shortages matter clinically because they are associated with insufficient treatment, delayed or cancelled care, poor adherence, longer hospital stays, more medication errors, harms from alternative therapies, and even deaths (Yi et al., 2026). The pharmaceutical supply chain is therefore not merely a commercial channel for products but a critical health system function whose failure directly compromises continuity of care and health equity (Sanket & Ankitkumar, 2024). Another recurrent vulnerability is the opacity of upstream sourcing, because regulators know which API producers are linked to medicines in their own jurisdictions, but that information is often confidential and unavailable to buyers, the public, governments, and even regulators in other countries. This lack of transparency means that several marketed brands in one country may still depend on the same hidden upstream facility, so apparent competition does not guarantee true supply resilience. Greater transparency would allow governments to identify bottlenecks earlier, understand dependence on specific regions or sole producers, and choose mitigation measures with a clearer view of cost-effectiveness.

The importance of this point is illustrated by the piperacillin–tazobactam shortage, where policy-driven supplier consolidation in China and constrained supply from other facilities left Qilu as the only API producer, after which a 2016 explosion halted production and triggered a global shortage. The resulting collapse had international consequences severe enough that Germany temporarily allowed unauthorised medicines, while British clinicians reported higher costs and concerns about antibiotic resistance risks. This case showed that a medicine can move from commercial success to supply collapse within a few years when warning signs about concentration, complexity, and weak policy coordination are ignored. It also showed that market incentives alone do not reliably protect access to less profitable but clinically essential medicines such as generic antibiotics (Wells et al., 2024). Studies of antibiotic shortages more broadly reach a similar interpretation, arguing that geographic concentration in China is important but not sufficient to explain the problem, because the same economic forces that pushed Western firms to outsource low-profit lines also pressure Chinese manufacturers to reorient their production strategies. In that sense, shortages arise not only from where production is located but from the fragile political economy of medicines whose public health value exceeds their profitability. Cross-country reviews show that global shortages increased steadily between 2014 and 2025, with particularly important drivers including API concentration, low margins that discourage redundancy among generic manufacturers, and fragmented regulatory frameworks that delay mitigation. National responses have varied, but higher-income regions have tended to develop more preventive and data-driven systems such as early-warning mechanisms, quality risk management, and formal shortage prevention plans, whereas many Latin American systems remain import-dependent and reactive in procurement.

A large scoping review covering 69 studies published between 2008 and 2022 concludes that effective prevention and response require an integrated, cross-sectoral approach rather than isolated interventions at one point in the chain. That review emphasizes stronger interlinkages across the supply chain, better incentive structures, international data sharing, real-time monitoring infrastructure, and governance models that balance regulation with market sustainability. Other resilience reviews converge on a similar package of solutions: supplier diversification, inventory management, risk assessment, business continuity planning, digital technologies such as AI, IoT, blockchain, and real-time monitoring, plus sustained communication across stakeholders (Thrisha et al., 2026). Case examples from COVID-19, Hurricane Maria, and trade disputes suggest that resilience depends on both structural redundancy and operational agility, not on a single intervention.

Taiwan's experience during COVID-19 is especially instructive because it highlights a second type of shortage mechanism beyond overseas manufacturing failure: internal misallocation within domestic

distribution systems (Kuo et al., 2020). In Taiwan, there was no known nationwide essential shortage as of early September 2020, but local stockouts still occurred in community pharmacies because of distribution issues, nontransparent price negotiations, and intense profit competition. The recommended response included real-time open tracking of supply and demand, warnings in electronic prescribing systems, broader sourcing beyond one or two countries, increased domestic production, better audits, clearer referral pathways, and closer coordination among pharmacies, companies, pharmacists, and government agencies. This illustrates that resilience requires visibility and coordination inside the country as much as diversification outside it. For import-dependent developing countries, these global findings are highly relevant. Evidence from Pakistan links shortages to supplier concentration, currency devaluation, and inadequate inventory management, while also calling for stronger regulation, public-private collaboration, and support for domestic manufacturing (Hasan et al., 2025). This pattern is likely informative for countries such as Indonesia, where dependence on imported pharmaceuticals and limited local redundancy can amplify exposure to global shocks, even though the supplied papers do not provide Indonesia-wide national shortage metrics directly.

Within that broader context, the idea of a pesantren living pharmacy built around TOGA, or Family Medicinal Plants, emerges not as a replacement for modern pharmaceuticals but as a localized resilience strategy for health promotion, minor ailments, education, and partial self-reliance at community level. TOGA is described as a set of medicinal plants cultivated for family medicine needs so that a principle of independence in everyday care can be realized (Faridah et al., 2023). Community studies also describe family herbal medicine as relatively safe, easy to process, and useful for first aid in minor conditions such as fever, cough, joint inflammation, or general stamina support, though such claims in the supplied literature are framed as community-service descriptions rather than clinical trials of efficacy. That distinction matters because the evidence base for TOGA in these papers is mainly educational and participatory, not therapeutic in a strict clinical sense. Even so, the literature consistently shows that cultivating and using medicinal plants can increase community knowledge, practical skills, and motivation around self-care and preventive health. In an Islamic boarding school setting, student empowerment through participatory learning, consultation, training, coaching, and cultivation demonstrations improved knowledge and skills related to medicinal plants. The same study argues that local government participation could help sustain such programs through small industries producing healthy drinks from medicinal plants, suggesting a link between health resilience and modest economic development (Dewi et al., 2024).

Another Indonesian community intervention on TOGA for arthritis education found increased public knowledge and stronger motivation among housewives to use medicinal plants as an alternative for self-medication in minor complaints. A living pharmacy program in Labuhan Bilik similarly framed medicinal plant cultivation as a way to disseminate practical knowledge on herbal cultivation and use for maintaining health, especially by using available land productively in a tropical environment (Nisa & Dora, 2024). The Sojomerto TOGA initiative adds that these plants can be grown in narrow spaces and were used as a community awareness tool around land use and everyday responses to common flu and cough symptoms. In pesantren landscapes, the concept can extend beyond simple planting. A healing-garden project at an Islamic boarding school integrated a TOGA garden with relaxation and edible garden functions, and reported gains in community knowledge together with strong participation during planting and dissemination activities (Pratiwi et al., 2025).

Another pesantren-based community service project used vacant land for herbal cultivation, then trained students to formulate herbal powders, drinks, granules, effervescent powders, packaging, labelling, and website-based marketing, with reported gains in student knowledge and skills (Setiawati et al., 2024). These lower-ranked community papers do not address pharmaceutical supply-chain resilience directly, but they are relevant because they show how pesantren can function as local health-learning ecosystems that combine cultivation, education, small-scale processing, and social participation. A realistic management model therefore links two levels of resilience. At the macro level, the literature supports transparency, supplier diversification, regional manufacturing hubs, public-private partnerships, early warning systems, strategic reserves, and data-driven governance to reduce the probability of critical shortages. At the meso and micro level, especially in communities with limited access to formal healthcare supply, pesantren-based TOGA programs can strengthen knowledge, local organization, and modest first-line self-reliance for non-severe everyday health needs. The two levels should not be confused. TOGA cannot solve shortages of antibiotics, oncology drugs, sedatives, enzyme replacements, or other essential modern medicines whose absence threatens

severe morbidity and mortality. But TOGA can still be justified as a complementary social response because global shortages are prolonged, unequal, and structurally embedded, while local cultivation programs appear to build awareness, skills, participation, and limited household or institutional autonomy.

TOGA is consistently defined as a set of beneficial medicinal plants cultivated in home yards or nearby land and managed by families or communities to meet traditional medicine needs independently (Yani & Susilawati, 2023). Several papers also equate TOGA with “living pharmacy” or *apotek hidup*, emphasizing cultivation in home gardens or available land for self-care and household health support (Rahmawati et al., 2024). The concept is broader than medicine alone because TOGA plants are also described as kitchen spices, food ingredients, beverages, and nutritionally useful products with economic value, which makes the model relevant to both family health and community resilience (Pasila et al., 2025). In the Indonesian literature reviewed here, TOGA is presented as supporting preventive, promotive, curative, and rehabilitative functions rather than serving only as an emergency remedy (Damarwati et al., 2023). It is also framed as particularly valuable where access to clinics, primary care centers, or hospitals is limited, which helps explain why the model is relevant to communal living settings such as *pesantren*. Broader community evidence shows that 65%–80% of populations in developing countries use plants for treatment and that 48% of Indonesians reported using plants as traditional medicine in *Riskesdas 2018*, indicating that TOGA builds on an already substantial base of public familiarity rather than a marginal practice (Hidayati et al., 2023).

Within *pesantren*, this matters because *santri* live in dense residential environments that can increase vulnerability to common illnesses, while separation from family requires a degree of health independence and practical self-care knowledge (Yansen et al., 2024). The *pesantren* context also makes a living pharmacy model organizationally plausible, since *pesantren* are structured communities with dormitories, educational facilities, leadership by *kyai*, and a tradition of value-based collective life that can support long-term cultivation and supervision programs. Evidence from *pesantren* management research further suggests that successful institutional programs depend on participatory and integrative governance, clear organization, supervision, and stakeholder involvement, all of which are relevant if a TOGA garden is framed as a formal management model rather than a one-off activity (Izzah et al., 2025). In *pesantren*-based TOGA projects, the most common immediate aim is to improve student knowledge about medicinal plants and their uses. At Sahabat Cendekia Pariaman, *santriwati* received education on plant types that can be grown in the *pesantren* environment, the benefits of TOGA, and ways to process TOGA for disease prevention, health maintenance, and illness treatment.

At Miftahul Huda Indramayu, the intervention explicitly targeted student self-reliance in health care through both cultivation and processing of TOGA, indicating that the model extends beyond awareness into skill formation. The Indramayu training used both theory and practice, was delivered across four face-to-face sessions, and included the formation of TOGA groups and administrators, the creation of gardens, planting, and plant labeling, which together resemble the operational core of a management model. That same program reported that students gained interest and enthusiasm when introduced to the diversity of TOGA products, suggesting that the educational value of the model may increase when plants are linked to tangible outputs rather than taught only as abstract health knowledge. The outputs included ginger *dodol*, spinach chips, candied chili, moringa leaf *nastar*, and moringa sponge cake, which demonstrates that the TOGA concept in *pesantren* can incorporate functional foods and processed food products, not only liquid herbal medicine. This is consistent with the broader definition that TOGA can function as food or beverage products that are healthy, nutritious, attractive, and commercially valuable (Ulinniam et al., 2021).

Other community interventions outside *pesantren* reinforce this interpretation. Training in Cirebon combined outreach and counseling with preparation of infused water and instant ginger granules, and participants improved both their knowledge of traditional medicine and their practical ability to turn TOGA into marketable products. In Bantul, TOGA socialization introduced community members to plants such as red ginger, *temulawak*, ginger, and turmeric, then trained them to make useful products including herbal tea. In Banyumas, bay leaf was processed into practical tea bags as a healthy drink innovation, again showing that the “living pharmacy” model often merges medicinal use with everyday beverage production. These community findings are relevant because *pesantren*-based TOGA programs often use the same instructional logic of education, training, practice, and product demonstration. Several studies further stress that communication, information, education, and socialization are efficient methods for increasing TOGA use and

community participation, which supports their inclusion as core management functions in a pesantren model (Indraloka et al., 2025). The health rationale for TOGA in pesantren is usually framed around common mild conditions and general health maintenance rather than replacement of formal pharmaceuticals for severe disease. The literature describes TOGA as useful for minor ailments such as fever, cough, runny nose, stomach ache, and minor injuries. It is also repeatedly presented as an accessible alternative because it is relatively inexpensive, easy to process, and associated with fewer side effects than chemical drugs in these community reports. Some interventions explicitly aimed to reduce reliance on chemical medicine by strengthening public knowledge of herbal alternatives. At the same time, the evidence base here is largely educational and programmatic, so claims about clinical effectiveness should remain cautious. The strongest supported conclusion is that TOGA programs improve knowledge, motivation, awareness, and practical skills, not that they have been rigorously proven to substitute for essential modern medicines in institutional settings (Bakri et al., 2024). This distinction becomes especially important if the model is linked to a global drug availability crisis. The supplied TOGA papers do not measure global shortages directly, but they do support a logic of local resilience: when medicines are expensive, difficult to access, or overused, communities can strengthen first-line self-care capacity by cultivating medicinal plants that address minor health needs and support nutritional intake.

For a pesantren, that response is plausible because the institution combines land, labor, education, and a disciplined daily routine, all of which can sustain cultivation better than scattered household efforts. Ecological pesantren research shows that some pesantren already conduct plant-related learning practically, from seeding and planting to harvesting and post-harvest processing. In Garut, an eco-pesantren provided 12 hectares of land for a biodiversity laboratory, cultivated various plants and herbs using organic seeds, and used them as ingredients for herbal medicine and alternative food for students. That same case linked cultivation to broader environmental management, irrigation hygiene, and disease prevention, indicating that a living pharmacy can be integrated into a healthier pesantren ecosystem rather than treated as an isolated gardening activity (Andalas et al., 2026). Another ecological pesantren case described a permaculture-based system in which students learned agroecology, planted local crops and herbal plants such as roselle and Curcuma, processed harvests for self-consumption first, and marketed the surplus later to enhance economic value.

This sequence is highly relevant to a management model because it provides a clear hierarchy of goals: meet internal needs, improve food security, then commercialize the remainder. The economic dimension is prominent across many of the papers. TOGA products such as infused water, instant granules, herbal teas, packaged jamu, moringa chips, and herbal beverages are repeatedly described as having economic value and contributing to family or community income (Mufida et al., 2026). In Salimpek, a six-month empowerment program improved understanding of the herbal center village concept and highlighted TOGA's role in health, cosmetics, and local economic development, while also stressing the need for mentorship and government support. The Tato Macan program similarly linked unused land conversion, TOGA demo gardens, training, herbal product development, and new micro-enterprises, reporting benefits in health, household expenses, and additional income. Within pesantren, this matters because many institutions increasingly pursue entrepreneurship and life-skills education alongside religious formation. Studies on pesantrenpreneurship report that pesantren have developed business clusters such as agriculture, fisheries, cooperatives, and printing, and they build student interest through training, seminars, and direct involvement (Rahmati et al., 2023). Other pesantren studies show that gardening and entrepreneurship are already recognized life skills, and that students learn best when caregivers are involved and practice-based activities are embedded in institutional routines. Economic empowerment research at Daarul Ukhuwwah likewise found that independent business units can improve welfare, entrepreneurial experience, and social networks when leadership support and community cooperation are present, although weak management and SOP discipline can be obstacles.

These findings suggest that a pesantren living pharmacy model should not end at cultivation. It should include governance, training, post-harvest processing, hygiene standards, packaging, and market linkage if the institution wants TOGA to support both health and financial sustainability. This is also consistent with community programs in which participants were trained not only to plant but to process raw materials into herbal products with sale value. Some pesantren-focused empowerment reports describe exactly this transition. One study noted that student empowerment improved understanding of plant benefits and practice in making traditional herbal medicine, alongside creativity and productivity development. Another pesantren program that used vacant land for herbal plant management trained students in herbal formulation, packaging, labeling,

and marketing, and reported increased student knowledge and skills. Across the dataset, several plant groups recur in TOGA and living pharmacy initiatives, including ginger, turmeric, temulawak, kencur, galangal, basil, betel, lemongrass, moringa, bay leaf, clove, sappan wood, and cinnamon. These plants are chosen not only for medicinal associations but also because they are practical for cultivation, processing, and daily use as drinks, spices, or simple remedies. Some papers also emphasize that TOGA can be grown in narrow land, pots, or land adjacent to community buildings, which is useful for pesantren with limited space (Ulya & Zafi, 2021). Others recommend group-based administration, plant labeling, demonstrations, and mentoring, which together form practical design elements for long-term program continuity.

A reasonable synthesis of the literature is that a Pesantren Living Pharmacy Management Model would have at least six integrated components: leadership commitment, land allocation, student training, cultivation protocols, product processing, and sustainability partnerships. Leadership commitment is essential because pesantren studies repeatedly show that kyai, caregivers, and institutional structures shape whether programs become embedded practices rather than temporary projects. Land allocation matters because TOGA depends on accessible cultivation space, whether in home yards, pots, demonstration plots, or larger biodiversity laboratories (Rahman, 2022). Training is central because most successful programs used lectures, outreach, counseling, discussion, practical planting, and post-test or mentoring approaches to raise knowledge and skills. Cultivation protocols need to include group organization, planting schedules, labeling, maintenance, and where possible ecological or permaculture principles that reduce maintenance burden and strengthen sustainability. Product processing is important because the evidence consistently shows greater engagement when TOGA becomes herbal tea, jamu, infused water, granules, snacks, or ready-to-drink products rather than remaining raw plant material. Sustainability partnerships with local government, community groups, women's groups, or other stakeholders are also important because several programs cite mentoring, cooperation, and institutional support as conditions for continuity and scale (Nashir & Noor, 2025).

The most striking gap is the complete absence of a direct drug-shortage linkage. The corpus repeatedly describes TOGA as supporting self-medication, household medicine needs, and health independence, but none of the supplied studies analyzes TOGA as a strategic institutional response to pharmaceutical supply disruption. The second major gap is theory building: even participatory or evaluative studies focus on implementation success, knowledge gains, or motivation, not on a formal explanatory model of how pesantren governance could convert cultivation into resilience.

The literature does not provide a comprehensive pesantren management framework for living pharmacy implementation. Most studies describe short-cycle activities such as counseling, demonstration plots, seed distribution, land preparation, labeling, or training workshops, which are useful components but not a full institutional model. Demonstration approaches dominate, as in land preparation and staged implementation of village living pharmacies. Program design usually stops at counseling, planting, and maintenance training. Some studies add group formation and plant labeling, but not governance, budgeting, or institutional SOPs.

The literature does operationalize TOGA for health independence, but mainly at household or community level rather than as a pesantren-wide institutional strategy. Several studies explicitly frame TOGA as a route toward independent health, self-medication, and daily health support, and some show measurable gains in knowledge and skills after training. TOGA is framed as supporting traditional independent health and family medicine self-reliance. Training plus mentoring can substantially improve cultivation and processing capacity. The missing step is translation into pesantren systems such as curriculum, dormitory health units, procurement, and leadership structures.

No supplied study offers a substantive theory explaining how pesantren can manage living pharmacy programs to mitigate global medicine shortages. The strongest available building blocks are scattered mechanisms: knowledge improves uptake, participation improves sustainability, simple technology improves processing, and product development can create economic support. Knowledge is treated as a key driver of TOGA adoption and success. Participation and mentoring appear to sustain programs beyond one-time socialization. Economic value is repeatedly noted, but not integrated into a formal resilience theory.

The first research question asks how the global drug shortage crisis affects pesantren health service capacity. The broader literature shows that drug shortages reduce treatment continuity, undermine adherence, create delays in care, increase medication errors, and damage trust in health institutions. In low- and middle-income settings, the problem is sharper because availability and affordability of essential medicines remain

central access barriers, and patients often face higher out-of-pocket costs when public supplies fail. Pandemic-era evidence also shows that lockdowns, transport restrictions, low manufacturing capacity, and rising costs can interrupt essential health commodity supply with devastating health effects, which is relevant for import-dependent institutions such as pesantren clinics or informal boarding-school health units. At the institutional level, shortage conditions force health workers to spend extra time managing stock problems, selecting alternatives, and communicating uncertainty, which reduces service efficiency. The same literature also indicates that institutions need internal shortage policies, demand analysis, designated task forces, and communication systems to preserve rational medicine use during crises. For pesantren, this means the first objective is not only to describe external shortages, but to examine how those shortages weaken daily health management, minor-illness treatment capacity, procurement stability, and the ability of caregivers to respond to routine student health needs.

The second research question asks how TOGA cultivation can be integrated into pesantren management systems as a living pharmacy. The TOGA literature consistently defines these plants as medicinal species cultivated in household or nearby land to provide self-produced traditional remedies and support family or community health independence. Living pharmacy programs are similarly defined as the use of available land to grow medicinal plants for daily health needs, preventive health, and environmental improvement. Existing implementation studies show a fairly consistent operational sequence: needs assessment, land preparation, training, planting, labeling, mentoring, monitoring, and evaluation. Participatory approaches appear central, because programs that involve residents, teachers, students, or cadres in each stage report stronger knowledge gains and more sustained engagement. Educational strategies also matter: communication, information, education, counseling, and direct practice are repeatedly described as effective ways to increase understanding and utilization of TOGA.

The evidence further suggests that TOGA can be positioned not only as herbal medicine, but also as functional food, kitchen spice, green space, and environmental learning medium, which makes it compatible with pesantren education and daily life. Relevant plant examples in living pharmacy programs include ginger, turmeric, lemongrass, kencur, galangal, aloe vera, betel leaf, sambiloto, temulawak, and lime. These programs usually aim at mild complaints and self-care rather than substitution for essential pharmaceuticals, with the literature emphasizing common ailments, first-line health maintenance, and reduced dependence on hard-to-access medicines. Measured outcomes are mostly educational and behavioral: increased knowledge, better cultivation skills, greater use of medicinal plants, and stronger health self-reliance. For pesantren management, the integration question therefore becomes practical: how can TOGA be embedded into land use, student activities, caregiver supervision, health education, dormitory routines, and small-scale herbal processing so that the living pharmacy becomes an institutional program rather than a one-time planting project.

The third research question asks what management model can be developed for sustainable pesantren living pharmacy programs. The strongest management implication from the drug-shortage literature is that resilience requires coordinated governance, early warning, stakeholder communication, and preventive planning rather than reactive responses. The strongest implication from TOGA and living pharmacy studies is that sustainability depends on participation, mentoring, simple technologies, periodic monitoring, and external partnerships. Programs also perform better when they create formal groups, assign responsibility, and build continuity through community structures, as seen in TOGA group formation, cadre-based implementation, and cross-sector support. Several studies also recommend collaboration with local stakeholders and markets so that TOGA programs remain economically and operationally viable over time.

A reasonable model for the present study would therefore include six management components: leadership commitment, land and resource planning, TOGA education and training, cultivation and maintenance protocols, post-harvest processing and utilization, and monitoring-partnership mechanisms. Leadership commitment matters because institutional programs require clear responsibility and regular supervision during shortages. Land and resource planning matters because living pharmacies depend on using home, school, or community land systematically rather than incidentally. Education and training are essential because nearly all TOGA programs report knowledge gains only after structured counseling, demonstrations, and practical sessions. Cultivation protocols matter because planting, labeling, care routines, and monitoring are recurring operational steps in successful living pharmacy projects. Post-harvest use matters because TOGA programs become more sustainable when medicinal plants are processed into simple herbal preparations and

daily-use products. Monitoring and partnerships matter because long-term continuity depends on mentoring, local collaboration, and periodic evaluation.

The likely contribution of the study is therefore model building rather than mere description. The current literature provides many partial elements—community education, mini gardens, school-based living pharmacies, herbal coaching, cadre development, and self-care programs—but not a pesantren-specific management framework linked explicitly to pharmaceutical vulnerability. Existing global shortage reviews call for adaptive, evidence-based governance models, while TOGA studies show that local medicinal-plant systems can improve health independence and community participation. This creates a clear research niche: to translate scattered TOGA practices into a coherent pesantren living pharmacy management model that strengthens preparedness for medicine access disruption without overstating TOGA as a substitute for essential modern drugs.

RESEARCH METHODOLOGY

Research Design

This study addresses three linked issues: drug-shortage impacts, TOGA integration, and management model development. Grounded theory fits that bundle because it is used when the aim is to establish a theory related to a specific issue through iterative analysis, constant comparison, memo writing, and theoretical sampling. Corbin describes grounded theory as qualitative research for constructing theory from actual field data, and argues that theory construction remains relevant because theory can explain phenomena and guide later research and practice (Dillasamola et al., 2025).

The design also matches the substantive field. TOGA studies usually show practical empowerment, education, and health self-reliance, but they do not yet provide a pesantren-specific theory of how living pharmacy programs are managed institutionally. Pesantren health studies likewise identify leadership, internal systems, peer cadres, and preventive health programs as important, but they stop short of explaining how those elements could be integrated into a living pharmacy model for medicine-access resilience (Lastari et al., 2026).

Grounded theory is most defensible here because the study seeks a substantive theory, not only participant description. Charmaz and Thornberg note that grounded theory was developed to defend the quality of qualitative research by providing a method of theory construction, and their quality discussion centers on how researchers use the method logically to build theory. Vollstedt and Rezat similarly emphasize that grounded theory goes beyond mere description and aims to develop a theory empirically grounded in data through coding, theoretical sensitivity, theoretical sampling, and saturation.

This matters because the phenomenon under study is not a single event but an evolving management process: how pesantren leaders, caregivers, health cadres, and santri define health needs, organize TOGA cultivation, respond to limited medicine access, and sustain a living pharmacy program over time. Corbin locates grounded theory in pragmatism and symbolic interactionism, viewing people as active agents whose responses take the form of action and interaction based on socially derived definitions of situations. That orientation matches pesantren settings, where health practice is shaped by collective norms, leadership, routines, and institutional meanings rather than by isolated individual choices.

A grounded theory design is also justified because the available substantive literature points to fragmented empirical elements that need integration. TOGA is defined as medicinal plants managed in household or local yards to provide self-produced traditional medicines and reduce dependence on modern drugs that may be expensive or difficult to access. Community TOGA programs usually involve education, socialization, direct practice, and participation, and they tend to improve knowledge, cultivation skills, and health self-reliance (Wayan et al., 2025).

Yet those studies are largely programmatic rather than theoretical. Mini-garden projects report coordination with local leaders, site surveys, material preparation, and garden construction. Other TOGA initiatives report initial surveys, coordination with village officials, garden creation, counseling, and monitoring, again showing operational stages without a broader institutional theory. Community programs in Batu Tanjung add evidence that residents, village officials, and students can collaborate effectively in land preparation, planting, and model-garden development, but they still function as intervention reports rather than explanatory models.

Pesantren health studies show a similar pattern. Some pesantren have no Poskestren and rely on external clinics or puskesmas when students become ill, indicating unequal internal health-service capacity. Other pesantren have built health independence through Poskestren, health education, and santri husada cadres, suggesting that locally embedded systems can improve student health and diffuse innovations to other pesantren. A recent pesantren health-management study identifies participative kyai leadership, institutional SOPs and hygiene routines, and peer-based internal health cadres as three key elements of sustainable health education management. Together, these findings suggest that theory should emerge from how pesantren actors combine leadership, routine, land use, training, and peer organization, which is precisely the type of process grounded theory is built to capture.

A Strauss-and-Corbin design would normally proceed through iterative data collection and analysis rather than a fixed linear sequence. Their classic grounded theory text explicitly centers open coding, axial coding, selective coding, theoretical sampling, memos, diagrams, and criteria for judging the study. Later methodological summaries describe the same core architecture: coding procedures, theoretical sensitivity, theoretical sampling, and theoretical saturation are the main techniques for developing empirically grounded theory.

A practical design for this study would therefore begin with purposive entry into a pesantren context where TOGA or health self-reliance activities already exist or are emerging, then move toward theoretical sampling as categories develop. Fleet and Reeves note that Strauss-and-Corbin grounded theory combines induction with a deductive element through theoretical sampling, which guides the next steps in data collection and tests emerging concepts. They also emphasize that constant comparison and ongoing memo writing are significant elements of the analysis.

Research Settings

The research was conducted at five Islamic boarding schools (pesantren) located in X Regency, East Java, Indonesia. These pesantren were selected purposively because they represented diverse institutional characteristics, ranging from traditional (salaf) to modern pesantren, while sharing a common commitment to strengthening community health resilience through the cultivation of Family Medicinal Plants (Tanaman Obat Keluarga/TOGA). Although the institutions differ in terms of student population, land availability, educational management, and community engagement, each demonstrates considerable potential for implementing a sustainable living pharmacy management model. The research settings were designed to represent a variety of environmental, organizational, and socio-cultural contexts that could influence the successful cultivation and management of medicinal plants within pesantren communities.

The first research site, Pesantren A, is a medium-sized Islamic boarding school accommodating approximately 1,200 students. Situated in a semi-rural area approximately 15 kilometers from the regency capital, the pesantren possesses nearly 1.5 hectares of unused land surrounding its dormitory complex. Prior to the study, the institution maintained only a small herbal garden consisting of several medicinal plants such as ginger, turmeric, lemongrass, galangal, and aloe vera. These plants were cultivated primarily for household consumption rather than organized health services. The school leadership expressed a strong interest in expanding the herbal garden into an integrated living pharmacy that could serve students, teachers, and nearby residents. Administrators also considered medicinal plant cultivation an opportunity to integrate Islamic environmental ethics with practical agricultural education.

The second research setting, Pesantren B, is one of the oldest Islamic boarding schools in the district, enrolling approximately 2,300 students from different provinces in Indonesia. Located in a densely populated village, the pesantren has relatively limited agricultural land. Consequently, the institution has adopted innovative cultivation techniques, including vertical gardening, container planting, and greenhouse-based herbal production. During preliminary observations, administrators reported that fluctuations in pharmaceutical prices following several global supply chain disruptions had motivated the institution to seek alternative approaches for maintaining basic health services. The pesantren therefore viewed TOGA cultivation as a strategic initiative to enhance institutional self-reliance while preserving local knowledge regarding traditional medicinal plants.

The third site, Pesantren C, accommodates approximately 850 students and occupies nearly three hectares of agricultural land adjacent to rice fields and community farms. The pesantren has collaborated informally with local farmers to cultivate medicinal species including turmeric, ginger, kencur, cardamom, sambiloto, moringa, and temulawak. However, cultivation activities had previously been conducted without standardized planning, documentation, or management procedures. The institution therefore represented an ideal setting for examining how a structured living pharmacy management model could improve organizational effectiveness, resource utilization, and educational outcomes. Teachers believed that integrating TOGA into extracurricular learning could strengthen students' practical competencies in agriculture, entrepreneurship, environmental conservation, and community health promotion.

The fourth research location, Pesantren D, serves approximately 1,500 students and operates a small community health clinic managed by volunteer nurses and healthcare practitioners. Because the clinic frequently experienced shortages of certain over-the-counter medicines during periods of supply instability, administrators recognized the importance of maintaining a reliable source of medicinal plants for preventive healthcare and complementary treatment. The pesantren had already introduced several herbal preparations, including ginger beverages, turmeric extracts, and lemongrass infusions, but lacked a comprehensive management system governing cultivation, harvesting, storage, processing, quality control, and utilization. This institution therefore provided valuable insights into the integration of herbal resource management with existing healthcare services.

The fifth research setting, Pesantren E, is a relatively new Islamic boarding school established less than ten years ago. Despite accommodating only 650 students, the pesantren possesses more than four hectares of available land designated for educational agriculture. Institutional leaders intended to transform the campus into a model eco-pesantren emphasizing sustainable agriculture, environmental stewardship, renewable resource management, and community empowerment. Although no formal TOGA program had yet been implemented, school administrators demonstrated a high level of commitment to developing an integrated living pharmacy supported by student organizations, teachers, local government agencies, and surrounding communities. This emerging initiative made the pesantren particularly suitable for exploring factors influencing the early stages of program development.

The selection of these five pesantren was based on three principal considerations. First, each institution either had an existing TOGA cultivation program or expressed a clear organizational commitment to establishing a pesantren living pharmacy. This criterion ensured that the research could investigate both mature and emerging management practices while identifying common success factors and implementation challenges. Second, all participating institutions had experienced varying degrees of vulnerability to disruptions in pharmaceutical availability, increasing medicine prices, or delays in medical supply distribution. These experiences highlighted the strategic importance of strengthening local health resilience through sustainable medicinal plant cultivation. Third, each pesantren possessed sufficient land resources or innovative cultivation capacity, together with active support from school leaders, teachers, students, and surrounding communities. Strong stakeholder participation was considered essential because successful TOGA management depends not only on physical infrastructure but also on organizational commitment, collaborative governance, environmental awareness, and continuous community involvement.

Data Sources

Data Sources for the study "Pesantren Living Pharmacy Management Model: Cultivation of Family Medicinal Plants (TOGA) as a Response to the Global Drug Availability Crisis" consist of primary and secondary sources. Primary data are collected directly through interviews, observations, and discussions with pesantren administrators (kyai, ustadz, and boarding supervisors), TOGA cultivation managers and coordinators, santri involved in living pharmacy programs, and health practitioners and herbal medicine experts (Makiah & Ziad, 2025). These participants provide firsthand information on program implementation, medicinal plant cultivation, health education, and management practices. Primary data are considered original information obtained directly from research participants (Alafiyah et al., 2025).

Secondary data include pesantren policy documents, health guidelines, TOGA cultivation records, program documentation, santri health logs, medication records, and relevant curriculum documents

(Wuetherick, 2010). These documents support triangulation and provide evidence regarding institutional policies, educational integration, and program sustainability. Previous studies also demonstrate that TOGA functions as a living pharmacy, strengthens community health resilience, and promotes self-medication using medicinal plants (Agustina et al., 2023).

Data Collection Techniques

The study employs three complementary qualitative data collection techniques. In-depth semi-structured interviews are conducted with pesantren administrators (kyai, ustadz, and boarding supervisors), TOGA managers, santri, and health practitioners to explore their experiences, perceptions, and practices regarding living pharmacy management and responses to drug shortages. Interviews provide rich, contextual information and allow participants to explain management processes, challenges, and strategies in depth (Taherdoost, 2021).

Participant observation is used to directly observe TOGA cultivation, herbal medicine processing, maintenance activities, and the daily utilization of medicinal plants within the pesantren environment. This enables the researcher to understand actual practices and compare observed behaviors with interview findings (Jayanto Kelutur et al., 2025).

Document analysis complements interviews and observations through the examination of pesantren policies, TOGA cultivation records, health documentation, curriculum materials, and herbal processing guidelines. Combining interviews, observations, and documentation strengthens data credibility through triangulation and provides a comprehensive understanding of the Pesantren Living Pharmacy Management Model (Nopita et al., 2026).

Data Analysis

The analytic goal is to move from raw accounts to a substantive management model. Open coding would identify early concepts from interview transcripts, fieldnotes, and documents, such as medicine-access problems, leadership support, land availability, student participation, health routines, external collaboration, and post-harvest use (Arista et al., 2024). Axial coding would then relate these concepts around conditions, actions, interactions, and consequences, which is consistent with Strauss-and-Corbin's coding paradigm and its focus on social process. Selective coding would finally integrate the major categories into a central explanatory storyline, such as how pesantren translate health vulnerability into organized living pharmacy practice through leadership, peer cadres, and routine cultivation systems.

Memo writing is essential because it documents analytic decisions and the emergence of relationships across categories. Theoretical sensitivity is equally important because the researcher must notice subtle differences between, for example, symbolic support from leaders and actual institutionalization through SOPs, schedules, and role assignments. The study should continue sampling and comparing cases until theoretical saturation is reached, meaning additional data no longer add materially new properties to the core categories (Rianti & Triwinarto, 2020).

RESULT AND DISCUSSION

Sub-theme of Results and Discussion 1

Sub-theme 1 concerns institutional vulnerability, health system gaps, and community-based self-reliance in pesantren, all of which make health independence an urgent foundation for a Pesantren Living Pharmacy Management Model based on TOGA cultivation. Pesantren are inherently exposed to health risks because they concentrate large numbers of students in shared dormitory environments, where illness can spread quickly and minor cases can escalate into wider outbreaks if monitoring and prevention are weak (Hendarmin et al., 2021). This vulnerability became especially visible during the COVID-19 period, when pesantren were identified as transmission clusters and thousands of santri were reported infected, showing that religious boarding institutions face distinctive public health pressures that cannot be managed only through external crisis response (Baidowi et al., 2021).

Pesantren vulnerability is first rooted in the communal boarding structure that defines the institution itself. Dormitory-based life is central to pesantren education because santri live, study, worship, and socialize

in one integrated environment (Handayani et al., 2022). That same closeness, however, increases the probability that infectious disease, seasonal illness, minor emergencies, and other health disturbances will circulate rapidly across the resident population (Joni et al., 2024). Evidence from pesantren health studies consistently describes these institutions as places at risk of transmission, especially when dense occupancy is combined with unhealthy behavior, limited facilities, or inadequate environmental sanitation (Pulihasih et al., 2024).

The pandemic period sharpened this diagnosis rather than creating it from nothing. Research on pesantren during COVID-19 found that some institutions became new infection clusters, while offline learning and continued residential life forced pesantren to manage risk under conditions very different from ordinary day schools (Nida & Labibah, 2021). The significance of this evidence lies in the fact that pesantren cannot suspend their communal character without undermining their educational essence; direct formation, discipline, and independence are embedded in everyday co-residence. As a result, vulnerability in pesantren is not incidental but structural: it emerges from the same institutional form that makes pesantren socially and pedagogically distinctive.

A second layer of vulnerability concerns the limited internal capacity of many pesantren health systems. Several studies note that health problems in pesantren remain numerous and diverse, yet knowledge about proper personal and environmental care is often still inadequate among santri. Some pesantren also face media and information constraints that make it harder for residents to access reliable health knowledge related to problems they encounter repeatedly. This weakness is compounded by evidence from East Java showing that only 37.2% of 4,046 pesantren had a health post, indicating that a large share of institutions still lacked basic internal infrastructure for identifying and managing health problems systematically (Ayomi et al., 2025).

Because health risks in pesantren are recurrent, internal, and community-wide, the urgency of health independence is not merely normative but operational. Indonesian health policy has emphasized community empowerment in health, and within the pesantren context this means empowering santri and other pesantren residents rather than relying exclusively on outside intervention. The formation of Poskestren and other health-oriented pesantren programs reflects this policy direction, but the literature suggests that the deeper goal is the creation of residents who can monitor, prevent, and respond to everyday health threats through promotive and preventive action.

This urgency is reinforced by findings on santri-based empowerment models. Community-based surveillance in pesantren is explicitly described as a self-reliance pattern, in which health problems are identified by the community and then addressed with support from health workers. The proposed formation of trained santri-based surveillance cadres shows that health improvement in pesantren depends not only on treatment availability, but also on resident responsibility, health monitoring, and skills in early identification of problems. A parallel technology-based program at An-Nur Pesantren found that education improved santri knowledge scores from 69 to 91 and enabled strong performance in nutritional assessment and digital recording of health risks, suggesting that health independence can be built through practical systems, not only through slogans.

Evidence from the Santri Husada program points in the same direction. Pesantren with active health education programs showed better health-sector performance, broader acceptance of health promotion, replication of activities across institutions, and stronger institutional reputation as “healthy pesantren”. The key implication is that health independence is not only defensive; it can become an asset for organizational legitimacy, educational quality, and long-term institutional resilience. In this sense, pesantren health independence should be understood as a strategic capacity to reduce risk, strengthen internal governance, and sustain the pesantren’s educational mission under unstable health conditions.

The urgency of health independence in pesantren also extends beyond infectious disease to mental and psychosocial health. Recent studies show that boarding schools often prioritize academic achievement while

overlooking holistic well-being, and in pesantren the health and social connectedness dimensions can be among the weakest aspects of student well-being (Thoyibah et al., 2025). Strict rules, emotional pressure, limited personal time, social isolation, and adaptation problems have all been identified as factors that contribute to stress, anxiety, discomfort, or dropout risk among santri (Anwar & Julia, 2022).

These findings matter because health independence in pesantren must be interpreted holistically, not only as independence in handling minor physical illness. Peer support has been shown to improve self-efficacy and independence in inclusive pesantren settings, especially when emotional, instrumental, and informational support are available (Azizah et al., 2025). Other work shows that pesantren resilience during crisis is strengthened by holistic approaches spanning education, religion, economics, health, and social life. Mental health studies further suggest that spiritual practice, counseling, and social-emotional learning all have roles in building santri resilience, although the evidence also notes limitations when mentoring systems lack clinical expertise for serious cases (Lusiana et al., 2026).

This broader perspective is highly relevant to the proposed living pharmacy model. TOGA cannot solve every health challenge in pesantren, and the evidence does not support treating medicinal plant cultivation as a substitute for formal medical care or professional psychological support. However, the literature does support viewing TOGA as one component within a larger architecture of pesantren self-reliance, where health knowledge, peer support, surveillance, prevention, and culturally grounded care are integrated rather than separated.

Within this framework, Family Medicinal Plants (TOGA) become important because they directly connect local resources, daily health practices, and the principle of self-medication for minor conditions. Multiple studies define TOGA or living pharmacies as selected medicinal plants cultivated for household needs so that independence in family treatment can be realized (Azim et al., 2021). Their relevance increases in settings where access to health services is limited or where communities need affordable first-line responses for mild illness, because TOGA is described as useful for everyday needs, first aid for minor ailments, and support for independent traditional health practices.

The literature also shows that TOGA development depends less on plant availability alone than on knowledge, organization, and cultivation practice. Public knowledge strongly influences successful TOGA use. Community interventions that combine counseling, demonstration plots, training, seed provision, and mentoring repeatedly increase knowledge, motivation, and practical skills related to medicinal plant cultivation and use. In one program, average knowledge scores increased from 48 to 90 after training, with a very large effect size, indicating that properly designed educational intervention can rapidly build local competence in health-supporting plant management (Rudini et al., 2024).

For pesantren, this evidence is especially significant because many institutions possess yards or communal land that can be reorganized into productive living pharmacy spaces. Research on TOGA consistently emphasizes the use of home or communal land for herbal cultivation, the feasibility of planting in limited spaces, and the potential to convert underused land into a health-supporting and economically valuable resource (Anggriyani et al., 2024). Studies also report that TOGA programs generate additional benefits such as environmental greening, aesthetic improvement, supplementary income, product development, and local entrepreneurship (Itmam et al., 2025). This multi-functionality matters because pesantren health independence is more likely to be sustainable when linked to education, ecology, and micro-economy rather than framed only as emergency preparedness.

A pesantren-based living pharmacy model would therefore fit well with existing evidence on participatory empowerment. Training, mentoring, simple technologies, and active community participation have been shown to strengthen both self-reliance in medicine and the sustainability of TOGA initiatives. Earlier references cited in the TOGA literature also include a herbal-therapy-based santri empowerment model in Pondok Pesantren Al-Hidayah Batu Alang, indicating that the linkage between santri cadres and herbal

health empowerment already has a conceptual foothold in Indonesian community service scholarship (Karamina et al., 2020).

Sub-theme of Results and Discussion 2

Sub-theme 2 argues that TOGA cultivation can function as an institutional strategy in pesantren because it links health protection, land management, student training, and local resource resilience in one operational system.

TOGA programs are consistently framed as a way to increase health independence through the cultivation and use of medicinal plants. In crisis settings, this logic becomes more strategic because independently managed medicinal plants can provide an alternative when conventional medicine availability is disrupted (Mustaqim & Atabik, 2024).

For pesantren, this matters because institutional strategy is not only about treatment but also about organizing everyday prevention, self-care, and basic therapeutic capacity around assets already available on site. TOGA is defined not merely as a collection of herbs, but as a managed plot in yards, gardens, or fields dedicated to meeting routine medicinal needs (Kumalasari et al., 2020). That makes TOGA suitable for pesantren, which typically operate as residential communities and must maintain internal support systems rather than rely only on outside facilities.

Evidence from pesantren-specific studies supports this institutional framing. At Pesantren Sunan Kalijaga, herbal medicine development was integrated with religious learning, practical skills, and structured business-unit management, showing that medicinal plant activity can be embedded in the pesantren's educational and managerial core rather than treated as an informal side project. The pesantren also adapted prophetic medicine to local Indonesian herbal resources such as kencur, temulawak, cardamom, and Javanese chili, indicating that institutional herbal strategy can be both culturally grounded and locally ecological (Gunarsih et al., 2025).

A second pesantren example shows that herbal cultivation becomes strategic when it is tied to capacity-building and production systems. At Pondok Pesantren Al Wahid, the initial constraint was limited managerial and student skill in herbal plant management, but a program of counseling, technology introduction, training, practice, mentoring, and monitoring increased student knowledge and expanded cultivation from no plants to multiple herbal crops. The same program reported that 80% of trainees became skilled in producing herbal tea, showing that cultivation can be extended into simple downstream processing and value-added institutional products (Karamkhudoeva et al., 2021).

TOGA cultivation appears to deliver multiple institutional functions, not only medicinal supply. Several programs report that cultivation improves knowledge, practical skill, and day-to-day use of medicinal plants for common health needs. In Tarumajaya, limited access to formal services made TOGA especially relevant as an alternative natural treatment, while independent household planting increased after the intervention (Ratnadhiyani et al., 2026).

TOGA also supports environmental and spatial management by converting idle or underused land into productive health infrastructure. A community-based project revitalized 140 m² of vacant land into TOGA plots and showed measurable gains in both cultivation technique and utilization knowledge. Other studies similarly report the creation of green patches, improved yard use, and greener, cleaner local environments after TOGA planting (Febria et al., 2023).

The strategy can also generate economic and organizational spillovers. TOGA programs have been described as sustainable economic resources when combined with appropriate technology, advanced processing, and market linkage. In pesantren settings, this is especially important because herbal enterprises

can reinforce the long-standing self-autonomy of pesantren institutional management and finance (Rahayu et al., 2025).

Broader health-sovereignty research supports this direction. In Afghanistan, medicinal plants were described as fundamental to health sovereignty, treated common ailments, reduced some hospital visits, and provided livelihoods for about 25% of participants (Listyorini et al., 2025). Although that study is not about pesantren, it strengthens the argument that medicinal plant management can serve as a resilience asset when formal systems are constrained.

The evidence also shows that TOGA cultivation is not self-executing. Several studies identify low public understanding, limited cultivation expertise, and declining use due to knowledge gaps as major barriers (Fivintari et al., 2023). Programs therefore succeed when they institutionalize training, not when they simply distribute plants.

Long-term sustainability also depends on policy support and governance. The Bangkingan Herbal Corner case found strong potential in herbal empowerment but also identified gaps in legal protection, institutional support, funding consistency, and integration into formal planning (Natsir et al., 2024). This is directly relevant to pesantren: a living pharmacy model will likely work better if it is attached to clear internal roles, budget lines, maintenance routines, and external partnerships.

A further limitation is that medicinal plant use should be positioned as promotive, preventive, and complementary, not as a substitute for formal care. Community cadre models explicitly place TOGA within preventive and promotive frameworks, and scabies research in pesantren shows the relevance of herbal alternatives mainly as safer treatment development pathways rather than stand-alone replacements for all medical services (Hikmawati & Sulastri, 2024).

Sub-theme of Results and Discussion 3

The first sub-question is how a pesantren should start the model, and the evidence points to a diagnostic phase that maps land, needs, literacy, and institutional readiness. Several programs begin with observation, interviews, surveys, or asset-based assessment before any planting occurs. That first phase matters because low herbal literacy and weak land use are common baseline barriers, not minor implementation details (Sulistiyowati, 2024).

- Observation and interviews are explicit first steps in participatory living pharmacy programs.
- Idle or narrow land is repeatedly identified as usable once mapped systematically.
- Knowledge gaps about plant types, efficacy, and cultivation are common starting conditions.

The second sub-question is how pesantren should establish and manage the living pharmacy after assessment. The evidence supports a participatory cultivation phase that combines education, land preparation, planting, and routine maintenance. Programs use counseling, workshops, hands-on planting, and communal garden development rather than seed distribution alone. This phase is feasible even in constrained settings because TOGA can be grown in yards, pots, polybags, shelves, and narrow plots (Awilda et al., 2023).

- Participatory planting runs from land preparation to plant care in successful programs.
- Common crops include ginger, turmeric, aloe vera, lemongrass, cardamom, and moringa.
- Maintenance is simple but must be organized through watering, weeding, pruning, and basic fertilization.

The third sub-question is how cultivation becomes an institutional health strategy rather than a symbolic garden. The utilization phase covers health education, simple herbal preparation, first-line self-care for minor

conditions, and downstream product development. TOGA is repeatedly framed as supporting self-medication, minor ailment management, and family health independence. Several programs extend this into herbal teas, infused water, instant granules, and red ginger products, showing that pesantren can connect medicinal use with entrepreneurship and student skill formation (Wijayanti et al., 2023).

- TOGA supports first aid for minor illness and routine preventive health practices.
- Processing training enables simple herbal products with practical and economic value.
- Some programs explicitly link TOGA with reduced dependence on synthetic drugs and stronger self-reliance.

The final sub-question is how pesantren can sustain and improve the model over time. The literature points to monitoring, evaluation, reflection, dissemination, and follow-up mentoring as the fourth phase. This is where the garden becomes an institution rather than a one-off activity. Programs that measured outcomes usually found substantial gains in knowledge and cultivation skill, including increases from 48 to 90 in one training program, from 40% to 95% understanding in another, and from 53.57% to 83.33% in cultivation technique in a revitalized land project (Raising et al., 2023). For a pesantren, this model is best understood as a management cycle: assess local needs and land, cultivate through participatory organization, utilize for health and learning, and evaluate for continuity, product development, and institutional scaling.

CONCLUSION

This research yields four interconnected conclusions regarding the vulnerability of Islamic boarding schools (pesantren) to global pharmaceutical disruptions and the strategic role of Family Medicinal Plant (TOGA) cultivation as an institutional response.

First, pesantren face significant vulnerability to the global drug availability crisis. Structural fragility in pharmaceutical supply chains—driven by concentrated Active Pharmaceutical Ingredient (API) production, recent geopolitical trade tariffs (e.g., U.S. duties up to 104% on imports), and price volatilities—exposes these institutions to acute risks. This vulnerability is compounded by three internal constraints: limited on-site healthcare access (especially in rural areas), heavy dependence on externally supplied conventional drugs for daily ailments, and severe financial limitations that preclude buffer stockpiling. When global supplies falter, pesantren health systems falter with them.

Second, TOGA cultivation emerges as a strategically effective, culturally embedded response. Indonesian pesantren are ideally suited for this intervention due to abundant land, labor (santri), and the charismatic authority of kyai to mobilize action. TOGA aligns with indigenous Nusantara and Islamic (al-Tibb al-Nabawi) healing traditions, ensuring cultural acceptance. Empirically, educational interventions have demonstrated significant knowledge gains among santri—for instance, scores increasing from 45.45% to 67.88%, and from 63.4 to 84.7 in other programs (*p* < 0.05). Beyond health, TOGA provides economic viability through processed products (e.g., herbal powders, teas) and long-term sustainability through local, regenerative cultivation.

Third, the proposed Pesantren Living Pharmacy Management Model offers a practical four-phase framework for building health self-sufficiency. Planning, conducting health needs assessments, securing kyai leadership commitment, allocating resources, and integrating TOGA education into the curriculum. Cultivation, establishing and maintaining gardens with targeted medicinal species (e.g., ginger, turmeric, lemongrass) while actively engaging santri in hands-on care. Processing, training santri in harvesting, post-harvest handling, and transforming raw plants into standardized health products (e.g., jamu serbuk). Utilization, applying TOGA products for health maintenance, integrating them with existing clinic services, developing economic enterprises, and disseminating knowledge to surrounding communities.

Fourth, this model constitutes a substantive grounded theory for pesantren administrators. It is empirically grounded in multiple successful implementations, culturally embedded in the pesantren ecosystem, practically applicable with minimal external capital, and replicable across diverse institutional settings. The framework provides a clear causal logic: global supply chain disruption → pesantren exposure → strategic TOGA

adoption (via the 4 phases) → reduced pharmaceutical dependence and enhanced institutional health resilience. By shifting from passive pharmaceutical consumption to active herbal production, pesantren can transform themselves from vulnerable endpoints of global supply chains into self-reliant centers of community health and economic sustainability.

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