An Overview and Future Outlook of Indonesian Agroforestry: a Bibliographic and Literature Review

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Abstract. Indonesian agroforestry has been developed along the history, since been reported that home garden was practiced from 3,000 BC in Java Island. However, agroforestry practices were recognized to have less contribution to people welfare and environmental sustainability. Bibliometric and literature studies extracting baseline information from thousands of publications were done to analyse history and future projection of Indonesian agroforestry. Research and publication on Indonesian agroforestry is steadily increasing in number and quality. Topics related with traditional land use system and ecosystem services were frequently found, and therefore classified as motor themes. There were 16 most attractive commodities stated in the publications, including palm oil and rubber. Rubber agroforest was the only system that pay interest in several decades. There were many researches on indigenous agroforestry practices in the islands, but mostly (77%) concentrated in Java Island, especially studying private forest and home garden. The research on the issues of population pressure on forestland and efficient use of resources are the most popular topic in the decades. In the recent decade, broader theme of research was found including climate change and long-term livelihood. Based on the study, indigenous agroforestry is still important subject to study, but future roadmap of agroforestry must be developed by integrating forestry and agriculture approaches.

1 Introduction

Agroforestry is simply defined as a practice of managing land use by combining woody trees in the same area with crops or livestock, in a spatial or temporal arrangement [1]. In Indonesia, it was stated agroforestry system has been developed since ancient period, and the oldest agroforestry practice was home garden that developed since 3,000 BC [2], [3]. Many types of agroforestry practices were also found in all parts of the country along with population growth and social development.

Traditional or indigenous people believe that agroforestry is the most appropriate land use system in the tropical country because, in the contrary to intensive monoculture system, agroforestry is more sustainable and protect soil quality [4]. However, in fact in modern

agriculture, the traditional practices are replaced with intensive monoculture of crops and trees [4], [5]. Agroforestry offers an approach to integrate the local knowledge with modern science. Agroforestry is always related with a system or conceptual thinking in small scale level to gain high potential and transformative outputs [6].

Research in agroforestry has been developed since 1980s. In general, agroforestry research was initiated with inductive reasoning and experiential thinking in the first decades. Hence, it has been more oriented on applied approach to result broader objectives related with climate change and biodiversity in 2010s [7]. In the recent situation, there was a change on defining agroforestry to be more comprehensive aims in term of study on it, for example "multifaced activities to manage multicomponent and multiproduct" [8], [9]. In order to improve the performance of traditional agroforestry, it is necessary to propose a systematic procedure to identify and evaluate the existing practices, by involving all attributes of productivity, ecological sustainability and social adoptability [10].

Study or research on the current status of Indonesian agroforestry is a concern to promote strategy to develop future or modern agroforestry that more resource efficient align with the increasing of socio-economic and ecological problems in the country. This manuscript is a report on the retrieving or extraction process on acknowledged list of research and publication on Indonesian agroforestry within three decades, to be involved in establishing road map of future agroforestry development in the country.

2 Methods

To get an in-depth understanding of status of Indonesian agroforestry, the research was conducted by using bibliometric analysis and literature review on credible sources. The bibliometric analysis indicates the evolution path or the transformation during the time frame of the research, while the literature review provides an overview of the current state of literature.

2.1 Data collection

Database on research of global agroforestry is available in many digital libraries. The research was conducted within April 2021 with range of published database from 1988 to 2020 of two scientific database providers, i.e., Scopus and Google Scholar. Scopus has been developed and utilized by almost all high-level universities [11] and Google Scholar provides open access data sets [12].

2.2 Bibliometric analysis

Bibliometric data analysis was extracted from Scopus by using search string "agroforest*" while symbol * improved sensitivity on variation of keywords [13]; e.g., agroforestry, agroforest, agroforester; and booleans ("OR" "AND") were not used as search string in the bibliometric data. Scopus provides checklist of instant searching steps [14]. Researching on Scopus used a determined location Indonesia, and type of publication were journals, proceedings, books, and found a number of 655 publications. The data were downloaded and converted into a format that fit to the bibliometric tools [15] and data were converted into format of BibTex and Reference Manager (RefMan).

Bibliometric is able to quantitative analysis on academic literature such as journals, authors, countries and institutions [5]. This analysis was used to know the trend of agroforestry research in Indonesia. Bibliometric analysis on Scopus data set was done using bibliometric R packages [15] and visualization of similarities (VOS) using software viewer

[16]. Bibliometric R packages was used to extract information such as rate of yearly publication, number of author and frequency of citation [17]. Software R version 4.0.0 and R Studio 1.4.1106 was used this research with Biblioshiny Tools [18]. The results from Bibliometric R packages were annual number of publications (Fig. 1.), involved institutions (Fig. 2.) and strategic diagram (Fig. 3). VOS viewer collects data set and visualizes the term of bibliographic coupling, citation, co-citation, co-authorship and co-occurrence of the keywords by authors [19]. The results from VOS viewer were keyword network co-occurrence (Fig. 4) and top ten keywords (Table 3).

2.3 Literature Review Analysis

Literature review in the research was focused on the traditional agroforestry practices in Indonesia, based on the previous defined traditional agroforestry in the Southeast Asian Regional Centre for Tropical Biology SEAMEO (BIOTROP) and World Agroforestry Centre (ICRAF) publications (Table 2). The research utilized some keywords (Table 4) in the Scopus and the Google Scholar within the year of 1986 to 2020, location Indonesia, and type of publications were journals, proceedings and books. Data extraction from the Google Scholar was conducted using software Perish or Publish (PoP), to compile the reference and count scientific value of the articles [20].

Table 1. Search strings for literature review on Indonesian agroforestry

Digital Library	Search strings
Scopus	"teak AND agroforestry" "taungya" "home garden OR homegarden" "talun" "tembawang" "parak" "dusun OR dusung" "private forest" "mamar" "kaliwu" "simpukng" "rubber agroforestry" "pelak" "lembo" "repong damar" "damar agroforestry"
Google Scholar	"tumpangsari jati" "agroforestri jati" "pekarangan" "talun" "tembawang" "parak" "dusun agroforestri" "hutan rakyat" "mamar" "kaliwu" "simpukng" "rubber agroforestry" "pelak" "repong damar" "lembo"

The researching found 284 articles from the Scopus and 1691 articles from the Google Scholar. The data set was downloaded in CSV format, eliminated out-off topics on agroforestry. The researching by the Google Scholar from institutional repositories and unidentified publication year were excluded. Data elimination was done for duplicated articles in the Scopus and the Google Scholar, and compiled 1227 articles to proceed to data analysis.

The development of traditional practices in Indonesia was described by analysis of number of publications within 35 years (Table 1.). Thirty-two articles were selected to provide a comprehensive information of each agroforestry practices. The literature review in this research did not aim to systematic literature review (SLR), but to examine the previous findings with theoretical considerations [21].

Table 2. Traditional agroforestry practices in Indonesia

Agroforestry practices	System name	Location	Definition	Components
System based agroforestry	*Parak*	Maninjau, West Sumatera	Mixed garden on slope land between village and protected forest which involved heterogeneous components	Seasonal crops, perennial trees, shrubs,
	Taungya (*tumpangsari*)	Java	Agroforestry in the state-owned teak forest.	Teak based agroforestry includes food crops in early stages*
	Pekarangan (homegarden)	Java	Complex agroforestry system near residential or urban area	Various fruit tree species, seasonal crops, vegetables, medicinal herbs, ornamental plants*
	Talun (another type of home garden)	West Java	Combines annual crops in early stages (*talun* phase) followed by perennials and timber trees combination (*kebun* phase)	Various fruit tree species, timber tree species, bamboo, vegetables, livestock
	Hutan rakyat (private forest)	Java	Mixed plantation between timber tree species and others	Various timber tree species, fruit tree species
	Tembawang	Central Kalimantan and West Kalimantan	Forest garden related to complex agroforestry system near river flows	Dipterocarpaceae (*Shorea* spp.), rubber, nyatoh (*Palaquium* sp.), various fruit tree species
	Lembo	East Kalimantan and West Kalimantan	Fruit garden dominated by one fruit species or more	Various timber tree species, palm, bamboo, liana, exotic species (rubber, oil palm)
	Simpukng	West Kalimantan	Fruit garden	Various fruit tree species, rattan, bamboo, timber tree, fuelwood, vegetables, honey*

	Dusun or dusung	Moluccas	Simple or complex home garden	Fruit tree species, spices (clove, nutmeg, candlenut), crops, timber trees
	Mamar	East Nusa Tenggara	Agroforestry system located near water spring area, combination depends on plant dominations	Agrisilviculture
	*Kaliwu**	Sumba, East Nusa Tenggara *	Multispecies dry-land agroforestry*	Various fruit trees species, tubers*
Commodity based Agroforestry	*Jungle rubber agroforestry*	Jambi	Rubber based agroforestry	Rubber, timber tree species, fruit tree species, crops
	Pelak	Kerinci, Jambi	Coffee and cinnamon based agroforestry	Coffee, cinnamon, fruit tree species
	Repong damar	Lampung	Damar based agroforestry	*Shorea javanica*, various fruit tree species, timber tree species, palm, bamboo

Information retrieved from the ICRAF and SEAMEO (BIOTROP) from previous publications [22]–[25] except * extracted from other resources

3 Result and Discussion

3.1 Characteristic of Indonesian Agroforestry Research

Research on Indonesian agroforestry has increased positively since the year of 1988 (Figure 1), started from one Scopus indexed publication in 1988 to the peak number of 138 publications in 2020. The third decade (2011-2020) was the period with the highest number of publications accounted for 490 articles or 74% of the total publication related agroforestry. More specifically, the last five year was the most productive publication period that accounted for 56% of the total articles.
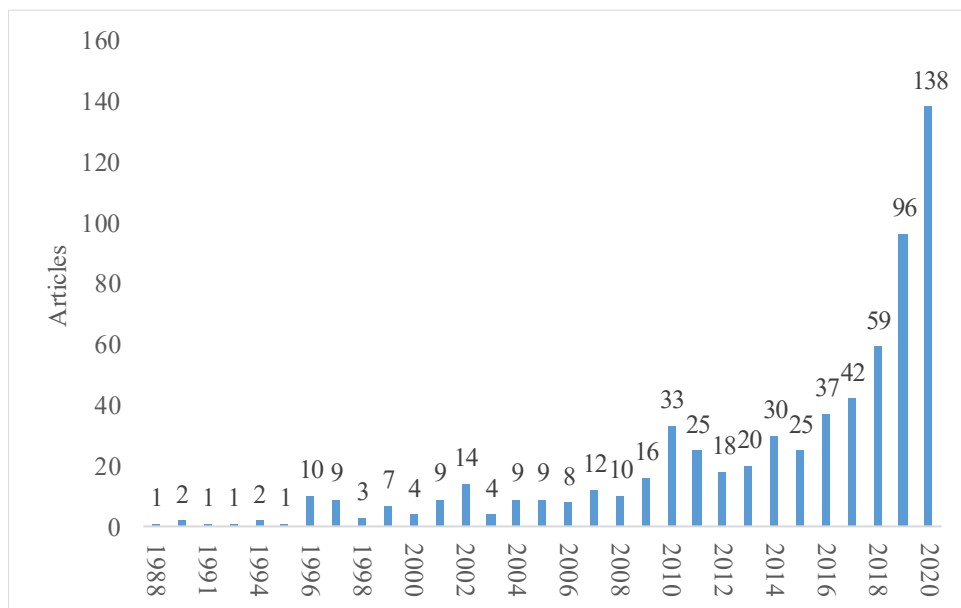

Fig. 1. Annual number of publications on Indonesian agroforestry in 1988-2020.

There were more than 200 worldwide institutions conduct publications related with Indonesian agroforestry. Figure 2 showed 20 highest ranking of institutions conduct publication on this theme. In the best five, there were two research institutes (ICRAF and CIFOR) and three universities, i.e., Goettingen University (DE), IPB university (ID) and Universitas Gadjah Mada (ID). Based on the country name, there were five country origin of the author affiliation, i.e., the Netherlands, Japan, USA and UK.
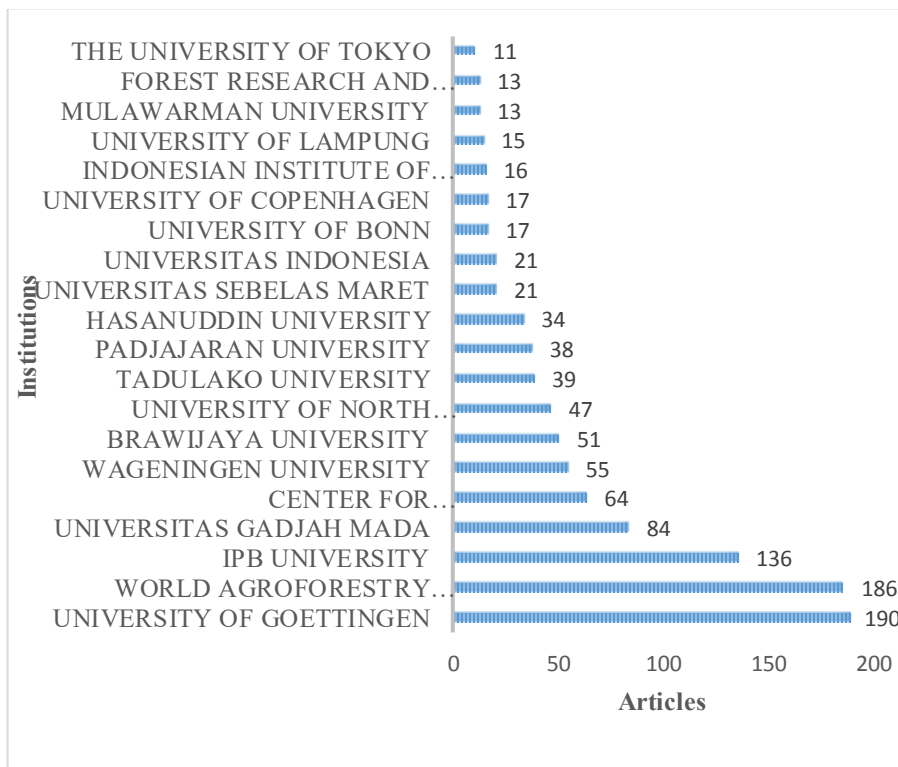
Fig. 2. Top 20 institutions in Indonesian involved in agroforestry research in 1988-2020

3.2 Thematic and Keyword Co-occurences on Indonesian Agroforestry

Thematic map in the bibliometric study maps the themes into the strategic diagram (Figure 3), showing four quadrants in the diagram, i.e., motor theme, basic theme, niche theme and emerging or declining theme [26]. Based on the figure, some number of themes related Indonesian agroforestry were developed and need attention on the quadrant of motor theme, including land use, sustainability and ecosystem services. Some of topics that under improving related with motor theme were food security, landscape management and tree-soil-crop interaction. Some themes that were classified as low density and low centrality were *Theobroma cacao*, soil fertility and smallholder.
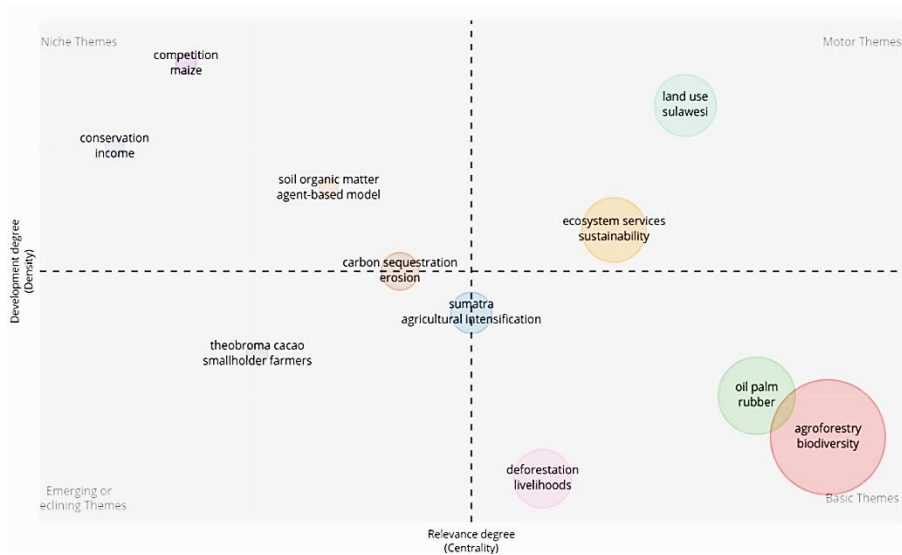
Fig. 3. The strategic diagram of Indonesia agroforestry research in 1988-2020.

Fig. 4 described variation of keywords high relevance to Indonesian agroforestry research in term of commodity and cluster of research theme. There were 16 commodities stated in the publications, and posed *Elaeis guineensis* (palm oil) dan *Hevea braziliensis* (rubber) as two most frequent object to appear. In the cluster of themes with wide network of keywords, the most frequent to appear were biodiversity, land use change, deforestation, carbon sequestration and climate change.
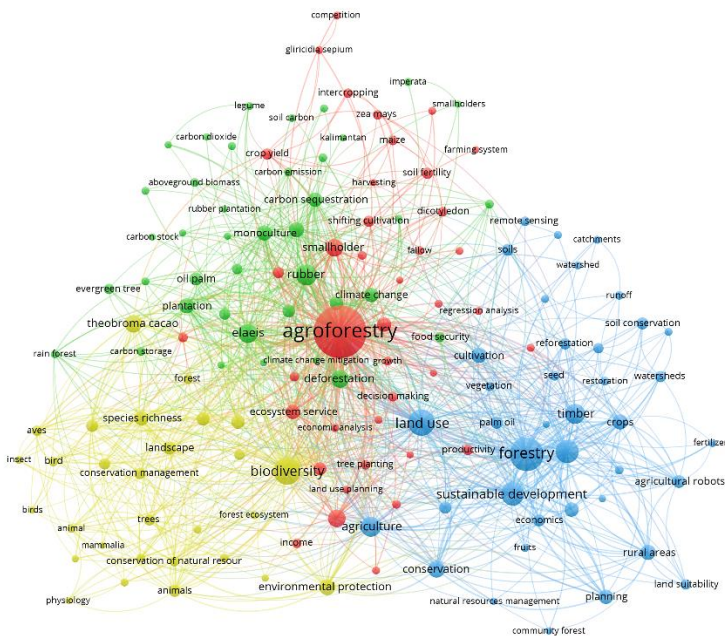

Fig. 4. Keyword co-occurrence of Indonesian agroforestry research in 1988-2020.

3.3 Overview of Traditional Agroforestry Practices in Indonesia

The development of study on Indonesian agroforestry (see Figure 3 and Figure 4) were highly related with the role of local or indigenous people. Characteristics of the traditional agroforestry were high in species diversity, specific site or location, performance biased and dependency on farmer preference as well as local tradition [27], [28]. Traditional agroforestry was practiced from ancient period, while rubber agroforestry and *parak* system has been developed in the 19th century [29], [30].

Almost all of the traditional agroforestry in Indonesia was initiated by opening natural forests, followed by crop cultivation for two to four years, and continued with forest-tree and fruit-tree planting [31]–[34], and short succession of the agroforestry occurred within 11–15-year periods [35]. Some of indigenous agroforestry in different locations in Indonesia established in secondary forest ecosystem e.g., *dusung* (in the Mollucas), *tembawang* and *simpukng* (in Kalimantan) and *repong damar* and rubber agroforestry (in Sumatra) [32], [36]–[39].

Agroforestry practices outside of Java Island is an important stage in degraded land restoration, part of reforestation strategy and biodiversity conservation [40], conserve high amount of carbon [31]. Traditional agroforestry is able to protect upstream and downstream areas, an example case of rubber agroforestry [41], control erosion in the *repong* and *keliwu* on hilly areas [32], [42] and conserve springs in karst soil of *mamar* [43].

In Java Island, *taungya* systems give opportunity to farmers to intercrop prior to canopy closure of the trees [44], [45]. Homegardens are the most adopted agroforestry system outside forest that combine annual and perennial crops, fruit trees, vegetables, herbs and ornamental flowers [46]–[49]. Community forests combine commercial trees of teak (*Tectona grandis*), albizia (*Falcataria moluccana*), gmelina (*Gmelina arborea*), and mahogany (*Switenia macrophylla*) [50]–[52]. Traditional agroforestry in private land in Java aims to provide food and cash crops for farmers, and timber that managed in traditional selection system [53].

Based on the commodities, traditional agroforestry produces non-timber forest products (NTFPs) such as rattan in the *simpukng* and *lembo* in Kalimantan [38], bamboo in *talun* in Java [33], green butter from *Shorea stenoptera* and resin from rubber and jelutung (*Dyera* sp.) and nyatoh (*Palaquium* sp.) in *tembawang* system in Kalimantan [54]. There are also NTFP of damar from *Shorea javanica* in *repong damar* system in Lampung [55], cinnamon bark and coffee in *parak* system in West Sumatra [56], as well as natural latex from rubber agroforest in Jambi [57].

Table 3. The development of publication on traditional agroforestry in Indonesia in 1986-2020

Agroforestry practices	1986-1999	2000-2005	2006-2010	2011-2015	2016-2020	N total
Java						**952**
taungya	0	0	2	5	19	26
pekarangan/homegarden	6	10	16	68	397	497
talun	4	1	2	2	4	13
community forest	5	9	56	155	191	416
Outside Java						**248**
pelak	1	0	0	0	0	1
parak	0	0	0	5	7	12
repong damar	2	4	3	1	4	14
jungle rubber AF	25	23	17	28	60	153
lembo	1	0	0	1	4	6
tembawang	0	0	1	15	42	58
simpukng	0	0	3	1	0	4
dusun	0	0	0	3	7	10
mamar	0	0	4	1	6	11
kaliwu	0	0	1	3	2	6

Sustainability of traditional agroforestry is the most important consideration in the transition process to "modern" agroforestry. Based on Table 3, we learned a lack of publication on traditional agroforestry practices such as *pelak*, *simpukng*, *lembo* and *kaliwu*, and probably impacts in the low recognition to the local knowledge. There is a fact that research on agroforestry in Indonesia focused in Java Island accounted up to 77% of total publications in the decades. Refer to [58], 56.10% of the people live in Java Island that probably related with the advance level of agroforestry practice in the island. In urban area, smallholder farmers manage the home garden more intensive than the people in rural area [7] consequently, agroforestry practices on densely populated area are more attractive to be studied than in less dense area.

3.4 Research Theme Evolution in Indonesian Agroforestry

Based on the bibliometric analysis, Figure 3 and Figure 4 showed broader and dynamic of themes of agroforestry research in the recent decades. In the Table 4, there are 10 keywords that are very frequent to appear in every periods.

Table 4. Top 10 keywords during on agroforestry research and publication in Indonesia in 1986-2020.

No.	1 (<1999)	N	2 (2000-2005)	N	3 (2006-2010)	N	4 (2011-2015)	N	5 (2016-2020)	N
1	Smallholders	53	Biodiversity	77	Theobroma cacao	169	Biodiversity	167	Forestry	522
2	Imperata	47	Land use	76	Species richness	126	Elaeis	144	Land use	346
3	Euphorbiaceae	40	Forestry	48	Agriculture	116	Land use	126	Biodiversity	330
4	Manihot esculenta	40	Theobroma cacao	38	Biodiversity	112	Deforestation	121	Sustainable development	313
5	Poaceae	40	Species richness	34	Land use change	105	Rubber	119	Elaeis	267
6	Shifting cultivation	38	Rubber	33	Biomass	83	Plantation	112	Monoculture	199
7	Grassland management	36	Zea mays	29	Forestry	81	Ecosystem services	94	Rubber	197
8	Bamboo	32	Insecta	28	Sustainable development	59	Environmental protection	93	Agriculture	180
9	Rubber	27	Smallholder	26	Climate Change	51	Forestry	82	Environmental protection	151
10	Nutrient cycling	27	Conservation	25	Environmental protection	51	Landscape	81	Conservation	142

In general, there is a similar interest of the author to publish agroforestry topic in Indonesia and in Asia Pacific [59]. Based on the study of agroforestry evolution, changes on global issues impacted in the most selected theme or topic on Indonesian agroforestry, including pathways of discourses on forestry field in 1970s to 2000s that consist of poverty and economic, environmental and ecosystem services, deforestation, biodiversity conservation and sustainable development [60].

In the global scope, development of agroforestry topics contributed to two main group of fields, i.e., natural science and social science [5]. This impacted on the broader applied science including improvement of farm productivity, impact on biodiversity, climate change strategy, as well as increasing welfare [61]–[63]. The development of agroforestry science was also affected by farmer behaviour to choose agroforestry system or commodities. Farmer attitude to respond the possible risks affected the choice of agroforestry practice [64].

Based on the evolution of agroforestry topics, jungle rubber was the only system that found in four periods or decades (1, 2, 4 and 5) with increasing number of publications in each period. The system may support Indonesia rubber production, that recognized as the second biggest latex producer (22% of the total world) following Thailand [65]. Rubber was introduced in the first 19th century in Jambi [7] and improved rubber agroforestry system (RAS) was practiced in 1994 by ICRAF and CIRAD in three different locations in Sumatra and Kalimantan[66].

3.5 Future Outlook of Indonesian Agroforestry

Our analysis convinced that Indonesian agroforestry development will be more challenged by increase of socio-economic and ecological problems, along with broader up the objectives to solve the local to global issues. Factors of people knowledge, investment and germplasm quality were able to decline adoption of agroforestry [67]. On the other hand, many indigenous agroforestry needs scientific improvements and innovative treatments.
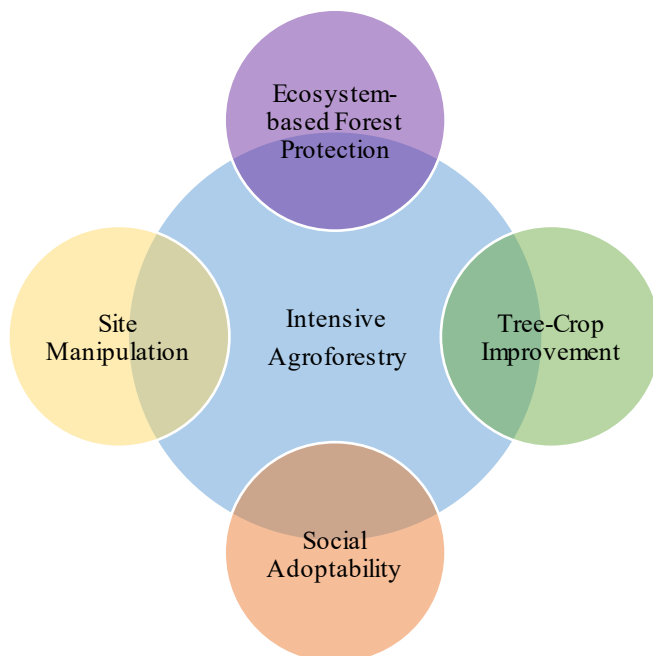

Fig. 5. Conceptual framework of Intensive Agroforestry

Intensification has been implemented in both agriculture and forestry as separated fields. Agriculture intensification aimed to fulfil basic need of food for the increasing population, especially in Java Island [68], [69]. It comprised of sets of treatments on farmland such as irrigation, utilization of high-quality seeds and pesticide, as well as technical assistance [70], but probably affected land degradation [71]. On forestry field, intensive silviculture that consists of tree improvement, site manipulation and plant protection [72], has been applied to improve timber production [73].

Intensification on the both fields may result in gaps to the newly paradigm or concept on integration of land use [74]. Therefore, a new approach namely intensive agroforestry is promoted to combine two existing land-use techniques of intensive silviculture and agronomy. The concept concerns to develop science and technology of seasonal crop cultivation that adaptable to forestry systems. The intensive agroforestry can be practiced to gain both socio-economic and ecological objectives.

References

1. S. Viswanath, P. A. Lubina, S. Subbanna, M. Sandhya, Adv. Agric. Res. Technol.**II**, 1 (2018)
2. O. Soemarwoto, in *Agroforestry: a Decade Development*, H. A. Steppler and P. K. R. Nair, Eds. International Council for Research in Agroforestry, (1987)
3. K. F. Wiersum, in *Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry*, B. M. Kumar and P. K. R. Nair, Eds. Springer Netherlands, (2006)
4. M. Lovrić, M. Rois-Díaz, M. den Herder, A. Pisanelli, N. Lovrić, P. J. Burgess, Agrofor. Syst.**92**, 4 (2018)
5. W. Liu, S. Yao, J. Wang, M. Liu, Sustain.**11**, 12 (2019)
6. A. Steiner, in *Agroforestry - The Future of Global Land Use*, Advances i., P.K.R. Nair and D. Garrity, Ed. Springer Dordrecht Heidelberg New York London, (2012)
7. Nair, D. Garrity, in *Agroforestry - The Future of Global Land Use*, **9**, 11, B. M. Kumar and P. K. R. Nair, Eds. The Netherlands, (2012)
8. O. I. Ollinaho, M. Kröger, J. Rural Stud.**82** (2021)
9. A. Jerneck, L. Olsson, J. Rural Stud.**32** (2013)
10. P. K. R. Nair, J. C. Dagar, Agrofor. Syst.**16**, 1 (1991)
11. A. W. Harzing, S. Alakangas, Scientometrics**106**, 2 (2016)
12. A. Martín-Martín, R. Costas, T. Van Leeuwen, E. Delgado López-Cózar, J. Informetr.**12**, 3 (2018)
13. S. Kugley, A. Wade, J. Thomas, Q. Mahood, A. K. Jørgensen, K. Hammerstrøm, N. Sathe, Campbell Syst. Rev.**13**, 1 (2017)
14. J. Stapleton, C. Carter, L. Bredahl, J. Acad. Librariansh.**46**, 5 (2020)
15. M. Aria, C. Cuccurullo, J. Informetr.**11**, 4 (2017)
16. N. J. van Eck, L. Waltman, Scientometrics**84**, 2 (2010)
17. H. Liu, F. Kong, H. Yin, A. Middel, X. Zheng, J. Huang, H. Xu, D. Wang, Z. Wen, Build. Environ.**196**, March (2021)
18. S. Ramanan S., A. K. George, S. B. Chavan, S. Kumar, S. Jayasubha, Ind. Crops Prod.**158**, July (2020)
19. J. M. Merigó, W. Pedrycz, R. Weber, C. de la Sotta, Inf. Sci. (Ny).**432** (2018)
20. M. Franceschet, Scientometrics**83**, 1 (2010)
21. L. Westholm, M. Ostwald, Agrofor. Syst.**94**, 2 (2020)
22. H. S. Arifin, M. A. Sardjono, L. Sundawati, T. Djogo, G. A. Wattimena, Widianto, Bahan Ajar Agroforestri (2003)
23. K. Hairiah, M. A. Sardjono, S. Sabarnurdin, Bahan Ajaran Agroforestri 1 (2003)

24. G. Michon, H. de Foresta, Ketika kebun berupa hutan: Agroforest Khas Indonesia Sebuah sumbangan masyarakat (1993)

25. G. M. dan W. D. H de Foresta, A Kusworo, *Ketika kebun berupa hutan: Agroforest Khas Indonesia Sebuah sumbangan masyarakat*. (2002)

26. M. J. Cobo, A. G. López-Herrera, E. Herrera-Viedma, F. Herrera, J. Informetr. **5**, 1 (2011)

27. B. Doddbasawa, Chittapur, M. Murthy, Bangladesh J. Bot. **47**, 4 (2018)

28. P. K. R. Nair, in *Conference of Agricultural and Rural Development Officers of the Asia Mission of USAID, Los Baños (Filipinas), 22-26 Apr 1985*, 2008, 12686

29. T. Martial, Uninet Biosci. Conf. **Vol 2 No 1** (2012)

30. B. Leimona, L. Joshi, Proj. Final Rep. (2010)

31. D. Astiani, Ripin, Biodiversitas **17**, 1 (2016)

32. N. F. Istiawati, S. Susilo, Budijanto, I. Nyoman Ruja, S. Widodo, IOP Conf. Ser. Earth Environ. Sci. **412**, 1 (2020)

33. K. Mizuno, S. S. Mugniesyah, A. S. Herianto, H. Tsujii, Southeast Asian Stud. **2**, 2 (2013)

34. M. Kaya, L. Kammesheidt, H. J. Weidelt, Agrofor. Syst. **54**, 3 (2002)

35. J. O. B. Christine E. Blinn, M. A. Pedlowski, R. H. W. A, Appl. Geogr. **43** (2013)

36. E. Insusanty, M. Ikhawan, E. Sadjati, IOP Conf. Ser. Earth Environ. Sci. **156**, 1 (2018)

37. Rafdinal, R. Pitopang, J. Phys. Conf. Ser. **1242**, 1 (2019)

38. E. Mulyoutami, R. Rismawan, L. Joshi, For. Ecol. Manage. **257**, 10 (2009)

39. T. M. Silaya, L. Siahaya, Int. J. Sci. Technol. Res. **9**, 5 (2020)

40. F. Montagnini, R. Metzel, *Integrating Landscapes: Agroforestry for Biodiversity Conservation and Food Sovereignty*, **12**, March. (2017)

41. E. Insusanty, M. Ikhawan, E. Sadjati, in *IOP Conference Series: Earth and Environmental Science*, **156**, 1 (2018)

42. G. N. Njurumana, J. Pemuliaan Tanam. hutan **13**, 2 (2019)

43. Dua K.S.Y.Klass, J Mns. dan Lingkung. **Vol. 16, N** (2009)

44. R. Rohdewohld, *Public administration in Indonesia*. Monash University Press, (1995)

45. J. Szulecka, K. Obidzinski, A. Dermawan, *Forest Policy and Economics*, **62**. (2016)

46. J. Iskandar, B. S. Iskandar, R. Partasasmita, Biodiversitas **17**, 1 (2016)

47. L. Hakim, N. R. Pamungkas, K. P. Wicaksono, Soemarno, Agrivita **40**, 3 (2018)

48. T. P. Agustina, Nisyawati, E. B. Walujo, in *AIP Conference Proceedings*, **2120** (2019)

49. Y. B. Prastiyo, R. L. Kaswanto, H. S. Arifin, IOP Conf. Ser. Earth Environ. Sci. **477**, 1 (2020)

50. R. R. Sari, K. Hairiah, Suyanto, J. Ekon. Pertan. dan Agribisnis **2**, 2 (2018)

51. D. S. Martono, S. Rahayu, Agri-Tek **17**, 2 (2017)

52. Y. Indrajaya, M. Siarudin, J. Penelit. Sos. Ekon. Kehutan. **Vol. 12 No** (2015)

53. S. Nur, I. Lestari, Y. Hero, **09**, 3 (2018)

54. Sumarhani, T. Kalima, **1**, Sundawati 1993 (2015)

55. G. Schroth, M. do Socorro Souza da Mota, Encycl. Agric. Food Syst. **1** (2014)

56. Y. Aumeeruddy, B. Sansonnens, Agrofor. Syst. **28**, 2 (1994)

57. S. F. Kennedy, B. Leimona, Z.-F. Yi, Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. **13**, 1 (2017)

58. BPS, *Potret Sensus Penduduk 2020 Menuju Satu Data Kependudukan Indonesia*. Badan Pusat Statistik, (2020)

59. S. Shin, K. T. Soe, H. Lee, T. H. Kim, S. Lee, M. S. Park, Forests **11**, 4 (2020)

60. B. Arts, M. Appelstrand, D. Kleinschmit, H. Pülzl, I. Vissen-Hamakers, R. Eba'a Atyi, T. Enters, K. Mcginley, Y. Yasmi, Embrac. Complex. Meet. challenges Int. For. Gov. **28** (2010)

61. J. P. Basu, New Zeal. J. For. Sci. **44**, 1 (2014)

62. J. Y. Coulibaly, B. Chiputwa, T. Nakelse, G. Kundhlande, Agric. Syst.**155**, March (2017)
63. J. Haggar, D. Pons, L. Saenz, M. Vides, Agric. Ecosyst. Environ.**283**, (2019)
64. E. Gosling, T. Knoke, E. Reith, A. Reyes Cáceres, C. Paul, Environ. Manage.(2021)
65. van Noordwijk M, C. R, S. FL, in *In: van Noordwijk M, ed. Sustainable development through trees on farms: agroforestry in its fifth decade.*, 2019
66. E. Penot, in *Book of abstracts of the 2nd World Congress of Agroforestry, 23-28 August 2009, Nairobi, Kenya*, WCA (2009)
67. P. Kiyani, J. Andoh, Y. Lee, D. K. Lee, Forest Sci. Technol.**13**, 4 (2017)
68. F. Agus, J. Penelit. dan Pengemb. Pertan.**30**, 4 (2011)
69. L. Potter, Asia Pac. Viewp.**42**, 2–3 (2001)
70. Erwidodo, G. Wittwer, R. Stringer, Indones. a Reforming World Econ. Eff. Agric. Trade Environ.May 2021 (2009)
71. P. M. Kopittke, N. W. Menzies, P. Wang, B. A. McKenna, E. Lombi, Environ. Int.**132**, May (2019)
72. Soekotjo, *Teknik Silvikultur Intensif (SILIN)*, 1st ed. UGM Press, 2009
73. P. H. S. Brancalion, O. Campoe, J. C. T. Mendes, C. Noel, G. G. Moreira, J. van Melis, J. L. Stape, J. Guillemot, Ecol. Appl.**29**, 2 (2019)
74. M. van Noordwijk, R. Coe, F. L. Sinclair, *Sustainable development through trees on farms:* (2019)