Diagnostic and Design Approach: Preparation Masterplan
Policies of Agroforestry Development in Madiun, Java, Indonesia

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Abstract. Deforestation and degraded forest land will continue to affect climate patterns in various places and trigger an increase in the frequency and intensity of weather events and extreme climate. The impacts felt by the community are quite a lot both in the social, economic, infrastructure, fishery, agriculture, health, tourism sectors, even in the areas of defence and security. Various anticipatory steps need to do by raising awareness of the community and relevant stakeholders to this issue of climate change. One of the actions of climate change adaptation in the capacity building is to encourage the emergence of national and local policies that address the concerns and readiness mitigation to cope with the impacts of climate change on various fronts, particularly in agriculture and food security. This study aims to encourage the preparation of the policy masterplan of agroforestry development as an effort to mitigate climate change in Madiun, East Java, Indonesia. With a Diagnostic and Design approach (D&D), a policy recommendation for agroforestry development in the medium and long-term developed.

The result of a D&D approach by the available resource potential, the agroforestry model that is feasible to be developed is agro-silviculture and agro-silvopastoral.

1. Introduction
Degradation of forest ecosystems remains a significant problem in almost all economies, and this is particularly severe in the more densely tropics country [1-3]. In Indonesia, deforestation and forest degradation is a significant problem for most of the savings, and notwithstanding the ongoing efforts to counter them, and the issues remain very critical [4]. In the context of climate change mitigation and adaptation, rehabilitation of degraded forest lands has become a priority for most economies [5].

The primary concern, therefore, is the impact of degradation on human well-being by reducing the flow of goods and services [6]. Vast tracts of forests are unable to produce products and services to their full potential. This is mainly a cause of considering the increasing demand for food, fuel, fibre and a whole range of ecological services like maintaining and improving watershed values [7][8]. Efforts to rehabilitate degraded lands have a long history and a wealth of experience has been gained based on the work done during the last many decades [2][6].

The ITTO Guidelines on restoration, management and rehabilitation of degraded and secondary forests. The principles and actions at two levels namely (a) policy, planning and management level and (b) stand level. Most often the outcomes of restoration/rehabilitation efforts have been mixed, and both successes and failures provide an opportunity to make refinements in policies and strategies.

One policy strategy to address deforestation with agroforestry model development. Agroforestry is an integrated land use system to increase land productivity to meet the needs of food, shelter, energy...
and environmental services, based on the development of science and technology following the local wisdom of the community [9-11]. Based on its constituent components, various forms of agroforestry can found, namely agrosilviculture, silvofishery, silvopasture, apiculture, and cultivation of medicinal plants under forest stands [10,12,13]. This shows that this system is not just a forest sector domain.

The agricultural sector contributes to Madiun district local revenue of over 30% of the total Gross Regional Domestic Product (GRDP) sectors. It's means that every policy of Madiun district government should lead to increased productivity of the leading areas. The top 5 GRDP data for Madiun district in 2016, as follows: Agriculture, Forestry and Fisheries (30.6%), Trading (16.2%), Engineering and Construction (11.2%), Processing Industry (10.09%), Communication and Information (7.96%). The economic development paradigm of Madiun district focuses on the harmonious development of strong agriculture with advanced industries and relies on the development of local resource potentials. Accomplish their mission, local government have the program agroforestry development has written in a document of regional medium-term development plans (RPJMD).

Several studies that done before, state that agroforestry is a land use system for the cultivation of tree and non-tree crops [10]. The use of technology in agroforestry is adjusted to the ecological and economic aspects [9, 10]. Agroforestry is a form of environmental interaction that has unique characteristics [2,3]. However, research and development of agroforestry continue to be carried out by the impacts of global climate change. Agroforestry is an alternative mitigation measure against climate change that affects the sustainability of people's livelihoods.

As a land-use system that has adapted to local wisdom, agroforestry can contribute to regional development strategies by providing employment opportunities (pro jobs), poverty reduction (pro-poor), increasing domestic economic (pro-growth), and maintaining environmental sustainability (pro-environment) [14]. The contribution of agroforestry realised at the local level in the form of contributions to the provision of employment, local economic development, and enhancement of environmental resilience that can further expand at the national level [9].

The Agroforestry system is expected to give the community the opportunity to not only have one job in increasing their income [15,10][13]. On the other hand, the pro-poor strategy is the driving force for government policy to be aimed at improving the welfare of the poor so that it will support the increase of regional economic growth. In addition to the financial contribution, the agroforestry system also has a positive impact on the conservation aspect [16]. This system is proven to maintain soil fertility, protect water catchment areas, contribute to carbon sequestration and support conservation efforts of biodiversity and landscape restoration [17, 18].

The paper aimed to create a master plan for Agroforestry development. Purpose of supporting the improvement of the people based economy of Agroforestry and business oriented, enhancing regional competitiveness and environmental sustainability.

2. Materials and Methods

2.1. Time and Location Research
This study was conducted for five months (from February to June 2018) in Madiun District, East Java Province, Indonesia.

2.2. Method of Data Collection and Analysis
In agroforestry developed a particular way of approach to analyse and recognise the problems of agroforestry practices. This method evolved from an already developed methodology of farming system research and development (FSR/D) [19]. Diagnosis is done by looking at the system more widely and openly. To understand the problems that exist on the plot scale micro, one should also pay attention to higher systems, such as farming systems and even land use systems. The development of the FSR/D approach for agroforestry systems resulted in a method known as Diagnostic and Design Approach (D&D) [20][21]. D&D is a methodology used to describe land use issues and to draw up its draft solutions in agroforestry systems [15, 21].

This method developed to assist researchers and field development staff in developing research plans and agroforestry development projects. With the development of a new paradigm of participatory
approaches. The method can also adapted to assist community facilitators or field facilitators in the context of sustainable agricultural development [14][15]. Each of the necessary steps and procedures in the D&D method can be done in a participatory way, from the pre-diagnosis stage to the implementation stage, e.g. mapping the problem and diagnosing it with Participatory Rural Appraisal (PRA) [20][15][19].

The necessary procedure of the D&D method consists of five essential steps: pre-diagnosis, diagnosis, evaluation, planning and implementation. Each level can be broken down into more detailed step sections. This procedure is not meant to complete in a single round but instead needs to be repeated throughout the development cycle or during a development project. This iterative mechanism allows for continuous improvement or revision until an optimal design is obtained and does not need to revise again. The necessary procedure of the D & D as follows [19,20].

**Table 1.** The required method of the D&D

| Stage 1 Pre-diagnosis |
|-----------------------|
| 1 System definition and location description (what system targeted?) |
| Describe the combination of resources, technology, and objectives of the land user. |
| 2 How does the system work? How is the organisation, how each component has the function to achieve the goal? |
| Strategies and purposes of production. |
| The composition of system components. |

| Stage 2 Diagnosis |
|-------------------|
| 1 How does the system work? What kind the problem, limited and constraint of a fundamental problem and intervention opportunity. |
| The problem in connection with the goals (low production, sustainability problems). |

| Stage 3 Evaluation |
|--------------------|
| 1 How does repaired the system performance? What are needed to increase the system performance? |
| Problem-solving specification or performance description after the intervention. |

| Stage 4 Planning |
|------------------|
| 1 What should be done to develop and disseminate an improved system? |
| Need research and development and extension. |

| Stage 5 Implementation |
|------------------------|
| 1 How to adjust to the new information? |
| Feedback from research stations, on-farm experiments and case studies. |

### 3. Results and Discussion

3.1. Overview of Development Agroforestry Areas.

Madiun district has an area of 101,086 Ha or 1,010.86 Km2, located on 111° 25' 45" - 111° 51' East longitude and 7° 12' - 7°48' 30" South latitude with administrative boundaries are: North: Bojonegoro District; East: Nganjuk District; South: Ponorogo District; West: Magetan District and Ngawi District. By administratively Madiun district consists of 206 villages in 15 sub-districts. For the preparation masterplan of agroforestry, the required data are from seven sub-districts. This study is limited to seven sub-districts in Madiun District, such as the table below:

3.2. Pre Diagnosis

Pre-diagnosis describes the potential resources, technologies and objectives of land use that are part of the agroforestry system. Pre-diagnosis descriptions provide an overview of the potential and location of action plans of agroforestry patterns. Besides, it also needs to be seen how the current system - resources and place - can function optimally to achieve the objectives in the form of expected aims and production objectives.
Table 2. Profile of Sub District location research.

| Sub District | Amount of Village | Area (Km²) |
|--------------|------------------|------------|
| Wungu        | 14               | 45.54      |
| Kare         | 8                | 190.85     |
| Gemarang     | 7                | 101.97     |
| Saradan      | 15               | 152.92     |
| Pilangkenceng| 18               | 81.34      |
| Wonoasri     | 10               | 33.93      |
| Madiun       | 13               | 35.93      |
|              | 85               | 642.48     |

Source: Bappeda Madiun, 2017.

3.2.1. System definition and location description and what system targeted?
Describe the combination of resources, technology, and objectives of the land user. Pre-diagnosis of natural resources based on secondary data consisting of area function maps, topographic maps and slope slopes of the region as well as soil type typology maps.

According to the regional function referral map, the Madiun regency area divided into three clusters for the use of territory, namely: (1) first cluster, seasonal crop and settlement cultivation area, (2) second cluster, annual crop cultivation area, and (3) third cluster, buffer zone. With this map, known that from seven sub-districts that represent the development of agroforestry masterplan, only one sub-district, namely Kare sub-district, is directed to the development of annual crop cultivation. While the other six sub-districts, namely Wungu, Gemarang, Saradan, Pilangkenceng, Wonoasri and Madiun addressed the expansion of annual crops and settlements.

Based on the results of the agroforestry roadmap study, the ideal area for the development of agroforestry action plans is an area that has the character regarding land suitability for crops and annual crops, suitability of conservation functions and compatibility as a buffer for water absorption. With criteria like this, the Kare sub-district is an ideal area for agroforestry action plans. In order, it does not rule out the possibility that agroforestry development can develop in clusters of seasonal crops and residential areas. With the fulfilment of one character, for example, there is land suitability for crops and annual crops. Details of the distribution of regional clusters according to their functions in Madiun district.

3.2.2. How does the system work? How is the organisation, how each component has the function to achieve the goal?
The institutions that involve the role of the parties involved in agroforestry action plans consist of Local Government Work Units and community groups, which have different but complementary functions and primary tasks. The identification of this role will be adjusted based on the purpose of the work that supports the implementation of the agroforestry action plan:

a. The Regional Development Planning Agency (Bappeda). The Regional Development Planning Agency (Bappeda) acts as a planner who has the task of implementing the formulation and implementation of regional policies in the field of regional development planning. It is also a verifier of the Local Government Work Units. Verification is intended to synchronise and evaluate program planning. Action plan this agroforestry will be the responsibility of the Local Government Work Units and become a joint forum to synergise the priorities of the development program. Besides, he has a vital role in determining budget allocations.

b. Agriculture Crops Services. The role of the Agriculture Crops Services is to carry out counselling and guidance to farmers to improve the quality of farmers human resources, increase the production of food crops and horticulture. He also plays a role in increasing the added value of agricultural products with quality post-harvest management. One field, namely the field of animal husbandry has the task of improving the area of superior livestock and fisheries.

c. Farmer User Groups. Farmers who join and work together to benefit economically, increase capacity, and improve the efficiency of their farming operations.
3.3. Diagnosis.
The results of observations and in-depth interviews obtained data that some people in the agroforestry plan action area are the people who base their economy on the agriculture and livestock sectors. Some of the population still depend their lives on forest areas for fodder, fuelwood and other benefits. Especially for the ten villages that are the object of observation, the source of livelihoods of agriculture-based residents in the lowlands to the highlands. Agricultural land in the ten communities classified as latosol to the alluvial soil, sandy clay structure to crumbs and nests, making it suitable for cultivation of agricultural and forestry crops.

3.3.1. How does the system work? What kind the problem, limited and constraint of the fundamental problem and intervention opportunity.
Analysis of natural resource potential and socio-economic potential provides an overview of the availability of resources and economic resources that can be developed to support plans for action on agroforestry patterns. The general economic potential problem is the weak competitiveness of superior products due to the absence of technological intervention to convert raw products into semi-finished products. The issue of economic potential that must be sought is the solution, namely: productivity, processing, marketing, and the suitability of selling prices.

1. Productivity. In general, the problems faced in the production of superior products are related to the environment, for example, the lack of water supply and pest attacks. These two things are the impact of climate change which has continued to deteriorate in the last two decades. Also, related to technical matters, among others, reduced labour, uneven distribution of fertilisers, and low mastery of technology.

2. Processing yield. The little knowledge of post-harvest technology causes most of the raw material is not carried out further post-harvest process. Although there is a small portion of traditional processing and some used for small industrial raw materials.

3. Marketing. As a result of the lack of adequate processing results, the impact seen in the process of selling results. Most of the sales results made with the middleman who comes to the production centres. And just a small portion sold directly market due to constraints on road problems and transportation costs.

4. Suitability of selling prices. Although the results of superior products do not have added value, most respondents think that the selling price received is considered appropriate and fair. This reason based on the amount received can be used to cover production costs and a small profit margin. Generally, respondents are still not sure and worried if there is processing of results. Is the selling price of the product produced will get a premium price from the middleman. Therefore, the strategy of selling raw materials seen as more profitable than having to spend costs on processing the product. The principle of cash and carry becomes a standard pattern in the transaction process in the sale of products.

3.4. Evaluation
The initial activities carried out by the community are maintenance and processing of land on a light or simple scale. Land clearing is carried out during leisure time as needed. Soil processing is usually only done on property that still has topsoil. At the beginning of the rainy season, farmers began planting crops such as corn, cassava, vegetables and others. Hilly land and slopes generally planted with annual crops and woody plants. Cassava plants are the primary choice for planting. People assume that cassava can survive in the dry season. Besides, tree plants that can survive in critical conditions generally planted on ridges such as teak and mahogany.

3.4.1. How does repaired the system performance? What is needed to increase the system performance? Temporally, farming activities begin with planting seasonal crops or crops combined with Multi-Purpose Trees (MPTs). Over time the MPTs species look more dominant. So that farming activities turn into mixed gardens (agroforestry systems). Based on the components of the compilation of agroforestry identified by the community at the location of the plan to act on agroforestry patterns, namely agrosilviculture, silvopasture and agrosilvopastoral.
Land characteristics in an area can function as an indicator of land conditions in the region. Land characteristics and land characteristics requirements for various types of constituent components in agroforestry systems, namely: land suitability criteria for agrosilviculture systems, land suitability for silvopasture systems, and land suitability criteria for agrosilvopastoral systems.

Evaluation of land suitability at the location of agroforestry action plans done by matching the quality and characteristics of the land with certain conditions of use or growing requirements for the plants to be developed. Growing needs of the types of plants commonly cultivated according to the form of tabulated land use for land evaluation purposes. The results of the land suitability evaluation for the species of plants whose land use is as follows:

1. Agrisilvicultur form. The components of woody plants and annual plants are of sufficient suitability, the limiting factors for teak (Tectona grandis) and bananas (Musa sp) is erosion hazards and land preparation because of the many rock outcrops on the ground. For mahogany trees (Swietenia sp) limiting factors are erosion hazards. Jackfruit tree (Artocarpus integrifolia) with limiting factors, namely nutrient retention, erosion hazard and land preparation. Rambutan (Nephelium lappaceum) is a limiting factor, namely water availability, nutrient retention, erosion hazard and land preparation. Durian (Durio zibethinus) and Cloves (Syzygium aromaticum) which are limiting factors are water availability and erosion hazard. Limiting factors such as nutrient retention can be improved by giving fertiliser inputs, liming, tillage or so on which can usually be overcome by farmers. Corn crop (Zea mays) and Casava (Manihot esculenta) suitability level are classified as marginal, where the limiting factor is the availability of water. This limiting factor will affect its productivity.

2. Silvopasture form. The main crops that expected are from elephant grass (Pennisetum purpureum), but here it is seen that elephant grass plants have the marginal level of land suitability, which is the limiting factor is nutrient retention. Its potential fitness can be increased to be entirely by fertiliser and liming, but this is a consideration for farmers because it will increase the input in its production.

3. Agrosilvopastoral form. The results of land suitability evaluation for woody plant components such as teak (Tectona grandis), mahogany (Swietenia sp), cloves (Syzygium aromaticum), have a suitable land suitability level, while mangoes (Mangifera indica), jackfruit (Artocarpus integrifolia), rambutan (Nephelium lappaceum), durian (Durio zibethinus) classified as marginal. Annual crops of banana (Musa sp), cocoa (Theobroma cacao L) and elephant grass feed (Pennisetum purpureum), with a level of suitability classified as marginal. The main inhibiting factor in the land is in the form of agrosilvopastoral is the nutrient rooting and retention media, where for the rooting media, especially the soil texture cannot be repaired, but for nutrient retention can be improved by liming activities, organic addition and fertilisation. Improvements to the inhibiting factors that can be recovered will increase the suitability of one level, for example, from a marginal fit to be entirely appropriate.

3.5. Planning
Performance of the agroforestry can improve by planning the system from the results of the Diagnosis and Evaluation. The plan includes what things are needed to improve the performance of agroforestry systems, problem-solving specifications, and intervention actions to enhance performance descriptions.

Make plans, and it is necessary to look back at the results of evaluating the characteristics of the area and the direction of land use in the area of an action plan for agroforestry patterns. Furthermore, the design of the development of agroforestry systems made the problem of challenges and the things that were the limiting factors.

1. Characteristics and direction of regional land use. Based on regional maps, maps of soil type typology distribution and climatological data (rainfall etc.), it can conclude that the characteristics of the land area are as follows:
   a. Slope, consisting of: slope 0-8%, slope 8-15%, slope 15-25%, slope 25-45% and slope > 45%.
   b. Soil types: grumusol, latosol, lithosol and mediteran with shallow to moderate solum physical characteristics, low humus content.
   c. Land use: community forest land, mixed gardens, fields, yards, rice fields and settlements.
   d. Climate: dry type C climate according to Schmidt Fergusson, with the highest rainfall in January with 20 days of rain and the lowest rainfall in August without rainy days.
e. Factors inhibiting land in the area include drainage and low permeability, moderate to high erosion, especially in the slope and back areas.

f. Directions for land use: recommendations for land use directions in the location research of agroforestry action plans, as follows:

Table 3. Regional land use direction.

| No | Land Use                        | Utilization                                      | Land Capability | Slope                                |
|----|--------------------------------|--------------------------------------------------|-----------------|--------------------------------------|
| 1  | Wetland agriculture            | Productive paddy fields                         | Deep solum      | Low slope, low erosion, high sedimentation |
| 2  | Community forest               | Left to the forest and intensification by reforestation | Medium solum    | Medium slope, moderate-high erosion, low sedimentation |
| 3  | Dry land agriculture and mixed gardens | Development of agroforestry systems               | Shallow solum   | Medium slope, moderate-high erosion, low sedimentation |
| 4  | Settlement                     | Productive yards with agroforestry patterns      | Superficial to moderate solum | Medium slope, moderate-high erosion, low sedimentation |
| 5  | Catchment of upstream areas    | Type conservation and enrichment species         | Shallow solum   | High slope, high erosion, low sedimentation |

3.6. Implementation

The agroforestry system in the research location can be mapped from the types of plants and livestock that are cultivated by the community. In general, plant components that comprise agroforestry systems have explained at the diagnosis stage of natural resource potential and socio-economic potential. Forms of agroforestry systems that develop can be seen in table 4.

Table 4. Design of agroforestry systems that are developing.

| No  | Agroforestry system | Types of plants                                                                 | Cropping pattern                                                                 |
|-----|---------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 1   | Agrosilviculture    | Mahogany, Teak, Corn, Rice                                                      | Irregular spacing (mixed cropping, mahogany as a hedgerow, teak and clove planted in groups, corn, peanuts, domestic soybeans and rice as the main crop). |
| 2   | Silvopasture and Agrosilvopastoral | Mahogany, Teak, Clove, Durian, Cocoa, Jackfruits, Corn, Elephant Grass and Livestock (Cow and Goat) | Irregular spacing (mixed cropping, mahogany as a hedgerow, teak and clove planted in groups, corn, peanuts, soybeans and local rice as the main crop. Elephant grass planted along the land boundary path). |

The design of the agroforestry system in Table 4 shows that the community is managing agroforestry land on a simple scale. Or called the traditional agroforestry pattern. The form is a combination of wood/tree plants with crops and or livestock. This practice found in a land management unit that forms landscapes from rural agroecosystems. Traditional agroforestry as any agricultural system, where trees both from planting or maintaining existing stands/plants become an integrated social-economic and ecological part of the whole system. This pattern has not utilised agroforestry technology that has developed according to the principles of forestry development. That is by combining commercial timber plants with high economic value crops. Field diagnostic results show that management objectives, resource allocation and technology interventions applied to agroforestry systems, can see in Table 5.
Table 5. Management objectives, resource allocation and technological interventions in agroforestry systems.

| No. | Management objectives | Technology used | Resource allocation | Production strategy |
|-----|-----------------------|-----------------|---------------------|---------------------|
| 1   | Forest plants         |                 |                     |                     |
|     | Sufficient for wood as building material and firewood (limited) | Sources of seeds are made by themselves or from the government Processing and maintenance are carried out by domestic workers (husband, wife and children). There is no processing action | Domestic labour Capital from household income There are no production facilities purchased | Traditional production methods (planting and waiting for harvest). |
|     | The raw material for making houses and the needs of household appliances | | | |
|     | Sold to the people in need. | | | |
|     | Sold to sawn timber from local and outside regions. | | | |
|     | Long-term crops for future family needs | | | |
| 2   | Agriculture plants    |                 |                     |                     |
|     | To meet household food needs (subsistence) | Source of seeds from the garden itself. There is no intensive fertilisation. There is no use of drug products. Family workers do the harvesting. There is no intensive treatment | Domestic labour Capital from household income | Processing and maintenance carried out semi-intensive Regular spacing. There is no pest control |
|     | For sale and the results are used for education, health, investment costs etc. | | | |
|     | Types enrichment | | | |
| 3   | Horticultural plants  |                 |                     |                     |
|     | For sale and the results are used for education, health, investment costs etc. | Sources of seedlings are made by themselves or by the government Semi-intensive fertilisation technology. Harvest is done by the workforce alone | Domestic labour Capital from household income | Processing and maintenance is carried out semi-intensive Irregular spacing. There is no pest control |
|     | Used alone | | | |
| 4   | Livestock commodities | | | |
For sale and the results are used for education, health, investment costs etc. Used as a long-term commodity for the family's future (savings). Domestic labour. There is no particular land for animal feed crops. Dirt not used for organic fertiliser intensively.

Sources of seeds from buying themselves, cattle traders and government assistance. Semi-intensive and caged maintenance system. There are animal health maintenance measures and artificial insemination systems. Source of capital from families and traders.

Results of the Diagnostic and Design analysis provide an overview of the direction of utilisation of the area in Table 5. The application of agroforestry action plans directed to the land use of community forests and dry land / mixed garden agriculture. The pattern or model developed is Silvopasture or Agrosilvopastoral.

Strategy for implementing agroforestry action plans with Agrosilvopastoral or Silvopasture systems must look back at the problems and challenges faced. Interventions are needed to overcome the issues and challenges so that agroforestry action patterns can be implemented. The development of mixed-use land use and dryland agriculture is recommended to be an agroforestry land. Both in the community forest area and in other areas of application.

The model of agroforestry development as a vegetative conservation method that formulated was a model of agrosilvopastoral by intervening in reducing the problems associated with the cultivation system. Overcoming every productivity problem of each land unit, improving farm management, overcoming the limited capacity of farmers and their families, and minimising external barriers faced by farmers.

4. Conclusions
Based on the results of the study of Diagnostic and Design analysis, financial and institutional analysis, the recommendations of agroforestry action plans in Madiun district are as follows: (a) The potential for agroforestry action plans with Silvopasture or Agrosilvopastoral patterns that are under socio-economic conditions, landscapes and topography are in Bodag Village, Kare District; (b) The landscape of agroforestry action plan areas in Madiun district must pay attention to the topography and type of land, namely the highlands, temperate and lowlands; (c) In general, Agrosilvopastoral models can develop for highland areas with the main livestock of Cow and Goats. The choice of livestock species must pay attention to the potential production factors of animal fooder plants that can develop after the character of the land. The potential for animal fooder production will guarantee agrosilvopastoral and silvopasture sustainability.

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