Regulatory challenges for tree seed source and certification in Indonesia: documentation versus productivity perspectives

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Abstract. Permen LHK: P.3/MENLHK/SETJEN/KUM.1/1/2020 and Perdirjen RLPS: P.05/V-SET/2010 are two major regulations for forest tree seed implementation in Indonesia. Referring some Articles in the Regulations, it seems to need further investigation and analysis because primary task of seed source has been confusing with tasks of genetic resources, breeding, and plantation. Varies in reproductive system and advanced technology are also neglected. In addition, documentative (referred as by-process) seems to be main priority rather than ensuring actual seed productivity (referred as by-product). Such condition causes some irrelevant standards in the regulations and posed a contra-productive for the seed sources and further certification. As a result, it tends to eliminate many potential stands as seed source, and poses a causality negative impact diminishing tree grower's interest for supplying seed and maintaining genetic resources. These problems and along with the increasing difficulty in seed supply have become challenges for the importance of ongoing monitoring and assessment of the existing regulations. This paper proposes some ideas addressing such challenges through regulatory improvements in optimizing the task of seed source, such as re-defining some standards, and focusing on real seed productivity. The improved regulation is also expected to stimulate involvement of community in seed source activities and maintaining potential genetic resources.

1. Introduction
Forest tree planting programs in the world are being massively implemented under various targets, such as species, sites, and goals in which it will need a sustaining in plant reproductive materials supply that include not only in the enough quantity but also in quality relevant to those targets. In Indonesia, industrial plantation forest is one of important economic activities and some areas enter the third rotation of planting. Along with this program, other forest land rehabilitation and restoration activities are taking place and it is recognized that the area and scheme are increasing as more various type of forest land and zone that is necessary to be a focus of target on the program. Whatever the types and schemes, the availability of seed and reproductive materials is a prerequisite to achieve the program success.

Proper selection of seeds may have a major influence on the success of forest tree planting program including the industrial plantation, land rehabilitation and restoration, and other purposes. There are many aspects on selection of the seeds to ensuring the quality and supply involving the seed source establishment, seed collection, seed testing, seed distribution and planting [1]. The proper seed source would be the main aspects in producing high quality seed to achieve the productivity of the trees suitable to target goals of planting. Therefore, quality standards relating to the tree seed source strengthened by appropriate regulatory features and further guidelines are needed to maximize the likelihood that the
quality seed produced is successful at achieving the plantation productivity and restoring the desired land rehabilitation while maintaining the sustain supply and allowing flexibility to involve various stakeholders participation.

Many countries have adopted forest tree seed guidelines in which the standards differ each other due to a considerable effort in harmonizing with the national condition, program and ecological [2]. However, all the guidelines present a similar main goal in guaranteeing the standards to ensure that the quality of seed produced would be reflected on the target and goals of planting program. In Indonesia, the guidelines for seed source standards are adopted as integral parts of the regulation for national forest tree seed implementation. The seed source standards would be used as a legal basis for further certification and the handling of seed.

In the pursuit of national land rehabilitation targets, the Government of Indonesia through Ministry of Environment and Forestry has issued forest tree seed regulation to achieve sustainable seed supply and to secure the quality of planting stock materials. Permen LHK Number P.3/MENLHK/SETJEN/KUM.1/1/2020 [3] and Perdirjen RLPS Number P.05/V-SET/2010 [4] are two major regulations for forest tree seed implementation in Indonesia. In terms of implementation, new adjustment on several articles related to seed source standards have been set in the new regulation. However, it still remains some problems and challenges, particularly related to the seed source standards by considering the varies in reproductive system from species diversity, population size, stand density, and appearing a missed-perception on task and function of the populations for seed production. Such conditions may trigger a concern occurring a contra-productive for the management of forest tree seed. Therefore, there is a need for ongoing monitoring and assessment of the forest tree seed regulation.

This paper presents the regulatory challenges for tree seed source and certification in Indonesia for ensuring real seed productivity with implications for community participation and genetic resources conservation. Specific goals include reviewing the regulation through a comparison of two different perspectives of documentative and productivity in terms of standards, implementation, available science and advanced technology, impacts to community participation and genetic resources. This paper also proposes some ideas addressing the challenges that could be considered for improving future regulation undertaken by the management authority, partners and stakeholders who concern for forest tree seed. Importantly, it is realised that some of arguments and opinions in this paper could be debatable due to the varies in experience and background. Therefore, some constructive discussions are necessary, and it may provide some challenges for further specific research study.

2. Forest tree seed and seed source: a biological overview

2.1. Life organism

The term of forest tree seed is defined as planting stock materials of forest tree species and, thus, the seed is living organism because biologically it contains the embryo that could grow to form a new tree under suitable condition both inside the seed and environment matters. The seeds are a product of sexual reproductive process on the tree. The seeds physically vary among the tree species, and the signs of living of the seeds for most species could not be observed visually until the germination process taken place. In addition, the genetic quality of the seeds is recognized from the estimated values derived from the parental genetic [5, 6]. Based on these biological characters, the seeds could not be referred as a living organism if unable to perform the germinated process. However, in the planting management practices, the seeds are also collected from vegetative propagation materials to produce a mass-scale multiplication of planting stocks [7]. In this case, the term of forest tree seed as a planting material refers the materials collected from both sexual and asexual reproduction.

In term of sexual reproduction, the seeds are produced from a process of mating among the parental trees in which the pollination process can happen through wind and water pollination, or through the works of vectors such as insects and animals. While that for asexual reproduction, the seeds are produced from multiplication of one individual parent tree through vegetative propagation. The both such parental population types are then biologically referred as seed source [3]. The seed source interacts with the environment, climates, being dependent on site-land, trees population and tree species [8]. In this case,
whatever the tree population condition as long as it can produce seeds, it can be referred as seed source. However, in management practices some specific standards have been placed on regulation and guidelines directly governing the activities relating to forest tree seed source [8, 9]. The seed source plays important role as an initial stage for further process and activities in the management of forest tree seed [1]. In some cases, the quality of seed source will reflect the genetic quality and productivity of the seed produced. From this point of view, it could be noted that the real product of seed source is the seeds or in other words it could be illustrated that the seed source is as the production machine, while the seeds is as the products.

2.2. Less-controlled by human: diversity, genetical, morphological, biological

One of the characters of many forest tree species is large diversity both in term of physiological, phenological, and genetic. In addition, biological rotation and time to reach sexual maturity is long, and morphological features of trees is large size. Such characters pose some difficulties in controlling and managing the reproduction process of trees. Unlike the crops species, human involvement in controlling the reproductive system of trees is more limited.

Considering the limitation as described in preceding paragraph and large amount of demand, seeds are commonly collected under open-pollination mechanism rather than the controlled pollination. As a consequence, the genetic quality of the seeds produced are less controllable, despite some approaches could be done through breeding process and advanced-molecular marker [10, 11]. However, the larger in population size and most of the parent population located in natural forest, such approaches could be unsucces and costly. From this point of view, determining of seeds productivity based on the parental performances become uncertain, although for some tree species the such approaches could be successfully practiced. In breeding practices, the genetic inheritance of parental to the off-spring could be approached by the estimates of heritability value which varies from 0 (as low heritance) to 1 (as high heritance) [6, 12]. Within species, this value could vary among the traits, sites and ages.

Concerning the female and male flower, the reproductive system of tree species also varies, particularly the co-occurrence of males, hermaphrodites and females in which the males produce pollen, hermaphrodites produce both pollen and seeds simultaneously, and females produce seeds (sex expression) [13]. Based on this co-occurrence, the management practice of the parental population for producing seed is a basis for the forest tree seed source in which a standard applied for one species could not be applicable for another. For example, one study in reproductive system using two different species of Eucalyptus show that the fertility rate is significantly different among the two species although they are planted in the same site with similar good growth rates [14].

Besides the varies in the reproductive system, the genetic quality within tree species also differs amongst the natural distribution population or provenance. It poses a difference in the genetic quality and seed productivity among the seed sources which are established using a basis of different original population. Harwood and William [15], and Nirsatmanto et al [16] report the provenances variation and a significantly different productivity of seed produced from seedling seed orchard of Acacia mangium that are established using different provenances from Papua New Guinea and Queensland-Australia. These cases suggest that the seed source would become a dynamic and flexible process incorporated many factors either genetic or non-genetic which cannot be rigidly regulated and guided using one standard.

3. Seed source in a forest tree seed system

Seeds are essential parts of tree planting program in which the existence is irreplaceable with another in reproducing the new trees. Up to now, there is no one technology that could replace the role of seeds in the program. In forest tree seed system, as a simple production process from upstream to downstream, there are four main steps: 1) seed source, 2) seeds, 3) plantation, 4) end-product of manufacturing industry (Figure 1). Seed source is placed on the first initial stage in the such system to produce the seeds. Each step in the system should be well maintained and connected each another to ensure the sustainability of production and program. The seed source and seeds cannot be solely managed and
separated without considering of other further downstream steps, such as plantation and industry or other end-product suitable to the target of program.

Figure 1. Forest tree seed system in industrial downstream

Seed source should produce suitable seeds both in quality and quantity. Therefore, assessing real productivity of the seeds produced on the basis of biological, physiological and ecological aspects is crucial to understand how the seed source standards should be defined and placed in the guidelines and regulations. A certification process is then commonly applied as a legal formal in ensuring the truth of the seed source according to the standards governed in the regulation and guidelines [3]. However, unmatched standards can pose a contra-productive to seed source which then consequently may provide some negative impacts not only directly to the success of program, but also indirectly to other sectors.

4. Current status and challenges of regulation in Indonesia: documentation versus productivity perspectives

4.1. Regulatory framework

Permen LHK Number P.3/MENLHK/SETJEN/KUM.1/1/2020 is a new released regulation as improvement of the previous regulation on forest tree seed implementation in Indonesia that was issued on 2020 [3]. This regulation governs a wide scopes of forest tree seed implementation which the outline involving aspects of genetic resources conservation, tree breeding and tree improvement, seed source establishment and seed procurement, certification, licensing and dues, supervising and coaching. Some Articles have been revised and improved adjusting to the current issues and conditions. The regulation should be followed by further lower levels regulation through Perdirjen as a detail guideline in the implementation. However, new Perdirjen is not released yet up to the middle 2021. Therefore, the Perdirjen RLPS Number P.05/V-SET/2010 issued in 2010 [4] is still enforced as the legal formal guideline.

Conducting reviews of the regulation would apparently be important in strengthening the forest tree seed system in Indonesia. This is because of some problems have appeared during the implementation, particularly dealing with the seed source matters. The diversity and complexity of reproduction system among tropical forest tree species as described in preceding paragraphs have affected the less effectiveness of regulation which pose some questions on how seed source should be re-defined. Therefore, of all the scopes governed, this paper presents a review focusing on the aspect of seed source, followed by its related certification.

In the regulations, seed source is defined as tree stand both located inside or outside of forest area specifically allocated for producing high quality seeds [3]. The seed source activities are specifically governed in the Chapters of Seed Procurement and Certification. There are ten Articles directly
governing the seed source standards as requirement to receiving a recognition certificate. The application of the standards is obligatory rather than provide a flexibility guidance on the implementation of procedures. If the candidate of seed source does not meet the standards, then it is determined as not eligible and not entitled to receive the certificate of seed source. In addition, the quality of seed source is classified into seven level classes in which each level applies specific standards without any consideration on the diverse genetic quality among populations within one species. The such classes, from the low to the high quality sequentially, are:

1. Identified seed stand
2. Selected seed stand
3. Seed production area
4. Provenance seed stand
5. Seedling seed orchard (SSO)
6. Clonal seed orchard (CSO)
7. Hedge orchard

The seven level classes can be further clustered into two groups based the process of seed source establishment. The first three classes are converted from natural stand or plantation that is not intended previously for seed production. While for other next classes are established specifically for seed production. Among all the standards applied for seed source, this paper presents a review focusing on some specific standards for requirements of size area and number of trees requirements which is often become a problem in the field implementation and tend to pose some wrong conceptions. In the regulations, standards for minimum size area and number of seed trees per unit seed source are required for all classes. Moreover, the standards also apply a specific range distance among the trees in the seed source, particularly for those from the natural stand. The common reasons for applying these standards are to maintain genetic diversity and to produce large amount seeds for whatever tree species targeted. For the high classes of SSO and CSO, additional standards are applied for the minimum number of plus-trees family regardless the reproductive system of species and the developed technology for crossing.

The regulations also provide the standards for establishing SSO and CSO on the basis of one method only, that is a converting of progeny trial to seed orchard. In this case, the SSO and CSO should be integrated with genetic testing process either in the same site area or in a separated area. The genetic quality of the seeds produced is then assessed and estimated from genetic performances of the parent. Standard for thinning of poorer trees or families should also be applied to retain trees selected for seed production in the orchard. It is assumed that random mating among the selected trees will accurately occur in the orchard, although such mating is commonly not easily realized and controlled under natural condition.

4.2. Wrong conception the task of seed source

Justification for governing some standards minimum in the regulation for seed source as described above indicates the appearing some wrong conceptions about the task of seed source. As the defined, the primary task of seed source is to produce quality seeds as planting stock materials. It could be argued that this task has been contaminated and confused with the tasks of genetic resources, breeding, and plantation, which pose a contra-productive for seed source. Standardization of minimum size area and number of seed trees in one unit seed orchard to keep genetic diversity is the function of conserving genetic resources and tree breeding rather than the function of seed source as unit of production. In addition, concerns about the small of genetic diversity in plantation, due to a planting using seeds from the less diversity of seed source, that could lead to further susceptibility to diseases is a part of management practices which can be overcome through planting seeds collected from several unit area of seed source rather than from polling of one large unit area seed source. In this matter, composing a comprehensive seed sourcing strategy [17] would be a solution rather than rigidly governing the standard of genetic diversity in one unit of seed source. On the other hand, in the genetic improvement perspective, a higher selection intensity of superior parent for seed trees could be adopted to produce a higher genetic quality of seeds [12]. It means that a seed source containing smaller number of superior
mother seed trees could be more productive rather than that containing higher number, particularly in seed source with a well-controlled genetic distance and crossing among the seed trees.

Another fact is found that the various reproductive system of species and advanced technologies seem to be neglected in the regulations. It causes a tendency that the regulation has applied some irrelevant standards. Even, flexibility to adopt other methods for seed source establishment considering the varies reproductive system of tree species, and the developed science and technology seems not to be allowed. Although occurring inbreeding depression as mating among relatives due the small number of seed trees in seed source is also a concern in the regulation, in practices the such inbreeding is mostly difficult to be controlled and avoided in the seed source, particularly in the first three classes of seed source. This is because inbreeding in a natural stand can occur through self-fertilization of individual trees and crossing among relatives that includes brother-sister, parent-offspring, and cousin mating [18, 19]. In this case, understanding the mating and reproductive system of species is more important rather than applying a strict standard for the minimum size area and number of seed trees in the seed source. Advanced technology on flowering and crossing for some species have been developed which can be used to precisely control the mating, particularly for seed orchard classes [20, 21, 22]. Data from studies in *Shorea leprosula* [23] and *S. platyclados* [24] provide some examples the application of regulation in selecting the stand as seed sources. These studies report that some potential tree stands are disqualified for seed source as a consequence of the limited number of available seed trees despite of they show a better growth and fruiting. In a fact, although small number of seed trees may produce less quantity of seed, the seed produced could be high quality that can be further multiplied through vegetative propagation technology to supply mass scale of planting stock materials [25]. From these points of view, governing the standards for minimum size area and number of seed trees in one unit area of seed source is likely not relevant, even lead to pose a less productive of the seed source.

4.3. *Less-focus on real productivity*:

Basically, the real productivity of a seed source is on the quality of seeds produced and not on the features of parent seed trees in the seed source. This can be achieved by ensuring the quality of the seed produced from seed source after proving its actual productivity in the field (referred as *by-product*). This is because the seeds are the materials which will be distributed to the field for planting. However, the regulation tends to govern the process on how to establishing seed source rather than verifying the seeds produced. In this case, the documentation (referred as *by-process*) seems to be the main priority rather than ensuring the actual productivity of the seed. As a result, seed source standards as a legal basis for further certification are less match and tend to eliminate many potential stands as a seed source. Through the *by-process*, the quality of seeds produced is only approached from the estimation and prediction values based on the performances of parent in the seed source. Standards for directly assessing the real productivity of seeds produced as in the *by-product* is not set.

The choice to apply the existing seed source standards through the *by-process* as determining on the seven classes of seed sources are likely to be based on the assumption that the advancing of process will provide better parent trees in producing seeds. However, such generalization cannot be applied with much precision for all tree species and pose a matter on what the classification of seed source should be. This is because the genetic quality widely varies among the populations within species. As the perspective of *by-product*, it can be said that populations with higher genetic qualities can produce higher quality seeds, although adopting a lower process, and vice versa. Whereas in the perspective of *by-process*, qualification of seed source based the seven classes can only be applied as long as they are established consistently using the same population of genetic-base. In a fact, the seed source is commonly established using a large of population distribution with a consequence that the real productivity competitiveness from seed produced is not always in line with the level of process adopted.

4.4. *Less-engagement for community’s interest*

The strict seed source standards focusing on the *by-process* poses the difficulty for some stakeholders, particularly small tree grower community, to involve in seed source establishment. As a result, besides
less ensuring the seed quality, the such standards also pose some causality negative impacts relating to diminishing tree grower's interest for supplying tree seed. In practices, most communities manage tree stands in limited area in which some of them may show a potential for seed production. However, they cannot propose the such stands as seed source due to not meet the standards for minimum size and often also the minimum number of seed trees, even if they have some evidences on proving the real quality and productivity of seeds produced. In such situation, the loss of genetic resources will occur due to economically the logging would be preferred rather than maintaining the tree stands for seed production.

5. Addressing the challenges
The extensive description of seed source and the standards as described in preceding paragraphs raise many issues and questions. Possibly the most poignant question is whether the governing standards of minimum size area and number of seed trees in one unit area of seed source is at all appropriate in ensuring the goals and task of seed sources in producing qualified seeds. Another question is whether the governed standards is the only one guideline in establishing qualified seed source. Ensuring real productivity of forest tree seed through a better and suitable governing of regulation and guidelines is expected to become increasingly important to address the need of qualified seeds for various of planting program in Indonesia.

Choosing which standards applied should refer the biological, physiological and genetic structures of the species targeted which commonly varies among the species. Relevant developed science and technology such as controlled-crosses, in-vitro culture, and molecular markers should be notified and regularly adopted to increase the effectiveness of seed source management, particularly in overcoming the size of area needed and number of seed trees in tolerating risks for inbreeding depression due to a mating among relatives.

Seed source can be re-defined as tree stands to facilitate a reproduction process either sexual or asexual to produce high quality seeds as planting materials, which then can be further multiplied for mass-scale quantity either direct or indirect. In this definition, minimum size of area and number of seed trees is not required as long as the real quality and productivity of seeds can be ensured. The such standards lead to promote and provide opportunities for the participation of interested parties, including local communities, industries, and individuals, in the tree seed supply. Appropriate standards should be promoted for these parties to enable them to have an economic benefit from seed supply activities. Moreover, many potential tree stands can be potentially explored and recognized over the wide ranges of distribution. Multiple seed source as compositing several numbers of small unit seed source can be then applied to meet the high demand of seeds. In this case, terms of quantity in the seed demand can be translated as an accumulating the seeds produced from several small unit area of seed sources rather than from the one single large unit area. It will not only provide a positive impact for conserving many genetic resources, but also easily maintaining and ensuring the safety from unexpected disturbances, such as fire, pests and diseases.

6. Conclusion
The paper concludes that the implementation of forest tree seed source standards in the existing regulation has focused on the documentative-perspective which caused that the current standards on seed source may be misguided. Therefore, attention and efforts must now be directed at strengthening the productivity-perspective based on real seed productivity of species target with a broader consideration associated with biological characters of species, the developed science and the available advanced technology, community’s participation and available genetic resources. Some irrelevant standards such as the minimum size of area and number of seed trees that is applied for one single unit of seed source should be revised. Flexibility of methods and procedures for seed source establishment should be recognized as long as the accurate evidences of real productivity from the seed produced is available. It will stimulate the increases community’s interest to involve in the seed supply and indirectly conserving genetic resources.
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