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Review Paper

A systematic review of soil erosion control practices on the agricultural land in Asia

Nur Syabeera Begum Nasir Ahmad*, Firuza Begham Mustafa, Safiah @ Yusmah Muhammad Yusoff, Gideon Didams

Department of Geography, Faculty of Arts and Social Sciences, University of Malaya, Kuala Lumpur, Malaysia

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A B S T R A C T

Soil is the basis of production in agriculture activities. The combination of intensive farming activities, improper farming practices, rainfall regimes, and topography conditions that taken place in agricultural land lead to the soil erosion problem. Soil erosion is the major constraint to agriculture that affects the yield production and degraded environmental sustainability. Furthermore, soil erosion that occurs in the agricultural area has jeopardized the sustainability of agriculture activities. Asia is one of the major agricultural producers in the world. It is essential to know how to mitigate soil erosion in Asian agricultural land. This systematic review aims to analyze the existing literature on research that has been done on control practices that had been taken in Asia agricultural land towards soil erosion. This article is guided by the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analysis) review method. The authors systematically reviewed the literature to study the control practices that been taken and tested to control soil erosion on the agricultural land in Asia. Accordingly, this systematic review identified 39 related studies about the topic based on the Web of Science and Scopus databases. This article divided the control practices into three main themes, which are agronomic practices, agrostological practices, and mechanical practices. The three main themes then produced a total of 11 sub-themes. Further specific and sustained research is needed to tackle this severe environmental problem through a better method, such as this systematic review method. The systematic review helps farmers and policymakers to implement the most practical approach to control and reduce soil erosion.

Contents

* Corresponding author.
E-mail address: ava180027@siswa.um.edu.my (N.S.B. Nasir Ahmad).

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1. Introduction

Land is very precious and plays an essential role in every living thing in this world. The Sustainable Development Goals (SDGs) (17 goals) is one of the ways proposed by the United Nations in 2015 to achieve a better and more sustainable future for all. An increase in pressure on land is highly likely to happen to achieve the SDGs that related to food, health, water, and climate (Keesstra et al., 2018). The current demographic trends and projected growth in the global population (to exceed nine billion by 2050) are estimated to result in a 60% increase in demand for food, feed, and fiber (Food and Agriculture Organization of the United Nations, 2015). In order to fulfill the desire to have a sustainable generation in term of no poverty, zero hunger, good health and wellbeing, land need to be explored to satisfy all these needs through agriculture and development. By exploring the land has created land degradation problems. Therefore, there is an urgent need to stop land degradation and establish frameworks for sustainable land systems (Food and Agriculture Organization of the United Nations, 2015). SDG 15.3 is specifically focused on land degradation neutrality. Soil is an important part of the land, and land degradation means will be affecting the soil systems that link to other systems such as the water system. Thus, to comply with the related SDGs, soil act as a critical element and need special attention. Soil science is one of the land-related disciplines and has an essential linked with several SDGs (Keesstra et al., 2016). One of the land degradation issues related to the soil that has attract different stakeholder attention is soil erosion.

Soil erosion is a global problem and rise as one of the major issues in many countries. Soil erosion generally means the destruction of soil by the action of natural phenomena (e.g., water, wind, and snow) and human-made factors (e.g., intensive and extensive agriculture) operating in conjunction (Zachar, 1982). According to Holy (1980), erosion can be classified as a natural or an accelerated process, depending on its intensity. In the first category, soil erosion occurs under normal conditions that take place for million years and is the means for the formation of new soils. While accelerated soil erosion is a result of human activities mostly through deforestation, overgrazing, and non-suitable farming practices where soil loss is much more than its formation. Soil erosion has negative impacts on agricultural production, quality of source water, and ecosystem health in terms of aquatic and land environment (Fayas, Abeysingha, Nirmanee, Samaratunga, & Mallawatantri, 2019). Few factors lead to soil erosion, which are soil erodibility, climate erosivity, terrain, and ground cover.

Soil is the basis of production in agriculture. Soil erosion that occurs in the agricultural area has jeopardized the sustainability of agriculture activities. Accelerated soil erosion has unfavorable environmental and economic impacts (Lal, 1998). Productivity effects of soil erosion are likely occurred both on-site and off-site. The on-site and off-site productivity loss due to soil erosion is attributed to three interacting effects, which are a reduction in soil quality, long-term productivity effects, short-term productivity effects (Lal, 2001). In the agricultural land, the detachment and segregation of particles from the soil mass happen when rain splashes hit the soil surface that already loose because of the improper agriculture practices such as intensive tillage. The soil particles could be thrown through the air over distances of several centimeters when the raindrops strike the soil surface (Morgan, 2005) and continuous exposure to heavy rainfall considerably weakens the soil. Many experimental studies have been conducted that show the influence of cropping on erosion rates (Nearing, Xie, Liu, & Ye, 2017). One of the effects of soil erosion is the denudation of topsoil and reduction of soil fertility which makes the land involves unfavorable for agriculture and will impact the production of yield in agricultural land. Apart from that, the fine materials of the eroded sediment, which will ultimately reach surface-water bodies will also create problems such as high sedimentation that then lead to flooding. If pesticides or fertilizers are contained in the eroded material, degradation of downstream water quality or ingestion of these contaminants by aquatic organisms is also likely to occur.

Asia produces 90% of the world's total supply of rice and produces a variety of subtropical and tropical fruit, primarily for local consumption (Narasimhan et al., 2019). Other than that, Asia also noted for several plantations of important cash crops such as tea, palm oil, coconut, sugarcane, and rubber. Unfortunately, despite generating good income for Asia, agriculture activities bring a negative impact on the environment, which is soil erosion. Asia probably has suffered more from soil erosion than any other continent. The total area that affected by soil erosion in Asia is 663 Mha (Lal, 2001), and this is considered higher compared to other continents. Borrelli et al. (2017), listed several soil erosion hot-spots that the erosion rates are higher than 20 Mg ha^{-1} yr^{-1}. The largest and most intensively eroded regions are predicted in few countries, and Asian countries are included. The Asian countries are China (0.47 million km2; 6.3% of the country), India (0.20 million km^2; 7.5% of the country) and Indonesia (0.076 million km^2; 5% of the country). Soil erosion has been a major environmental issue in China (Guo, Hao, & Liu, 2015). According to them, the regional differences in the soil loss rate in China were mainly observed on fallow land and farmland, however almost no differences were observed on forest, shrub, and grasslands. In the northwest and southwest China, the soil loss rates of farmland with conventional tillage were much higher than in most other countries (Guo et al., 2015). In India, the land degradation caused by erosion happened because of inappropriate agricultural practices and has a direct and adverse effect on the food and livelihood security of farmers (Bhattacharyya et al., 2016). According to Sumiahadi and Acar (2019), agricultural land is a major area with the highest soil erosion rate in Indonesia, and it is because of inappropriate agricultural practices such as agriculture activities on very steep slopes (more than 15%) and cultivation in a sloping area without any protective measures.

In an attempt to manage soil erosion off-site and on-site effects on the agricultural area in Asia, researchers have come out with proper control practices and strategies to reduce the amount of soil erosion. Controlling soil erosion is a matter of encouraging innovative approaches in land management techniques and methods. Lots of research had been done on control practices of soil erosion in terms of management every year in Asia. Studies mostly focus on the effect of different management practices, such as tillage operation (L. Wang et al., 2019), mulching (Pan et al., 2018), cover crop (Dai, Liu, Wang, Li, & Zhou, 2018), and intercropping (Sharma et al., 2017) on runoff generation and erosion process. Not only in Asia but studies on control practices also very encouraging in other parts of the world. Those studies also apply various kinds of practices, such as using straw mulch (Keesstra et al., 2019) and using catch crop (Cerdà, Rodrigo-Comino, Giménez-Morera, & Keesstra, 2018). Researchers in the related field has always come out with studies on how to deal with soil erosion problems and turned out with many findings that are sometimes conflicting. These happen may due to study differences, flaws, or chance (sampling variation). Therefore, it is not clear about the real situation, or the most reliable results should be used and practiced. Thus, a systematic review is needed to identify research that been done.

A systematic review is a review of clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyze data from the studies that included in the review. Statistical methods may or may not be used to analyze and summarize the results of the included studies (Higgins et al., 2011). To construct a relevant systematic review, this article was guided by the main research question - what are the soil erosion control practices that been tested the suitability of the practices in Asia agricultural land. The objectives of this article are to identifies and characterizes the soil erosion control practices research in the Asian agricultural areas. This article also aims to see how far the existing research has been conducted to control soil erosion and the most widely used method for controlling soil erosion. This article primarily focuses on the practices to control soil erosion in the agricultural area that is affected by topography, rainfall, and intensive agriculture activities. This study will only review soil erosion control practices on field level practice that will cover 11 subthemes as listed in the result.

2. Methodology

The method used to retrieve articles related to control soil erosion practices in Asia agricultural land was discussed in this section. A method called PRISMA was used to do this systematic literature review that includes resources, eligibility and exclusion criteria, the systematic review process, and data abstraction and analysis.

2.1. PRISMA

Preferred Reporting Items Systematic reviews and Meta-Analyses (PRISMA) guided this review article. Authors can ensure the transparent and complete reporting of systematic reviews and meta-analyses by using the PRISMA Statement (Liberati et al., 2009). PRISMA is actually developed for health and medical related review. But recently, PRISMA is often utilized within the environmental management field (Shaffril, Krauss, & Samsuddin, 2018). This is because, according to Sierra-Correa and Kintz (2015), PRISMA offers a few valuable advantages towards the systematic review process. The advantages are (i) a clear research questions that permits systematic review will be defined; (ii) the explicitly will identifies inclusion and exclusion criteria; and (iii) it aims to assess huge amount of relevant and available scientific literature as possible in defined time. Thus, those advantages make this method is suitable to be used in other fields, not only field that related to health and medical.

2.2. Information sources and search

The primary sources of information were the electronic journal databases Web of Science (WoS) and Scopus. WoS is a database established by Clarivate Analytics that covers about 256 disciplines such as science, social science, arts, and humanities from >33,000 journals. The temporal coverage of the database is from 1900 until the present. While Scopus is a database that provides by Elsevier that covers that cover 27 major disciplines with +300 minor disciplines such as health sciences, physical sciences, social sciences, and life sciences. Both databases have an Advanced Search tool that allows a rigorous search to find the related result. Boolean operators "AND" and "OR" were used to combine the strategic terms that had been decided earlier. The strategic terms came from the keyword and synonym of the concept and topic of the research. The studies retrieved after the search are imported into Endnote X9 © 2018 Clarivate software package for the detection and removal of duplicates. Although studies in soil erosion control practices are not limited to only these two electronic journal databases, but they host top peer-reviewed journals with high impacts factors in the field of soil erosion.

2.3. Eligibility and exclusion criteria

Few eligibility and exclusion criteria (Table 1) drive the search in the journal database which is the literature type, language, countries, and timeline. Only an online-based peer-reviewed article journal with empirical data was selected. This review leaves out valuable sources of information such as book, book chapter, book series, review article, and conference proceedings though some have empirical information as they are not always peer-reviewed. This is because peer-reviewed journal articles are informed by an interest in empirical studies that have gone through a rigorous research process to establish findings and conclusions (Shittu, 2019). Therefore, our approach intends to make a major effort to address the overwhelming breadth of information on the subject.

Next, the only article that published in the English language was considered to avoid confusion and difficulties in translating the non-English article journal. As for the timeline, a period of six years (2014–2019) was chosen for this systematic review. Studies conducted in the field of soil erosion are very encouraging from year to year. Therefore, the recent few years published articles about soil erosion control practices are enough to help in a better understanding of the suitable method to be used in dealing with a current soil erosion problem. Thus, people that involve in managing soil erosion can refer to these selected articles to practice the method that being tested in current research. Lastly, the objectives of this article are to focus only on Asia's agricultural land. Therefore, only articles focused on the Asian region are selected.

2.4. Systematic searching strategy

There is a four-phase flow diagram (Fig. 1) involved in this systematic review procedure that had been done in December

Table 1
The inclusion and exclusion criteria.

Criterion	Eligibility	Exclusion
Literature type	Research article journal	Review article journal, book, book chapter, book series, conference proceedings
Language	English	Non-English
Time line	Between 2014 and 2019	< 2014
Countries and region	Asian countries	Non-Asian countries

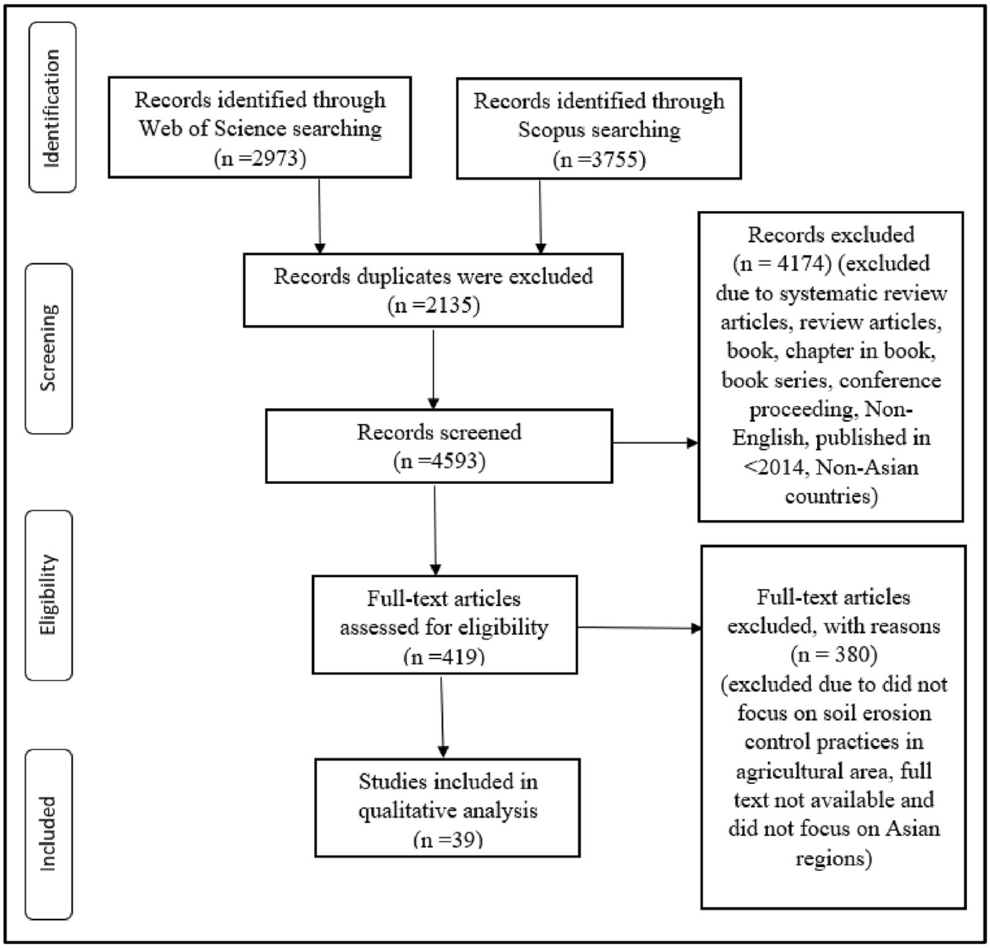

Fig. 1. The four-phase flow diagram of the study (Adapted from Moher, Liberati, Tetzlaff, Altman, & Grp, 2009).

Table 2
The search string used for the systematic review process.

Databases	Keywords
Web of Science	TS = ((“Soil erosion” OR “Soil loss” OR “Soil losses” OR “Eroded soil” OR “Runoff” OR “Sheet erosion” OR “Rill erosion” OR “Gully erosion” OR “Slope erosion”) AND (“Control practice*” OR “Management practice*” OR “Conservation practice*” OR “Control method*” OR “Management method*” OR “Conservation method*” OR “Control measure*” OR “Control strateg*”) AND (Agriculture OR Agricultural OR Farming OR Cultivation OR Husbandry OR Tillage OR Harvest*))
Scopus	TITTLE-ABS-KEY ((“Soil erosion” OR “Soil loss” OR “Soil losses” OR “Eroded soil” OR “Runoff” OR “Sheet erosion” OR “Rill erosion” OR “Gully erosion” OR “Slope erosion”) AND (“Control practice*” OR “Management practice*” OR “Conservation practice*” OR “Control method*” OR “Management method*” OR “Conservation method*” OR “Control measure*” OR “Control strateg*”) AND (Agriculture OR Agricultural OR Farming OR Cultivation OR Husbandry OR Tillage OR Harvest*))

2019. The first phase is identifying the keywords used in the search procedure. The keywords were obtained from the previous studies to find the synonym and the same keywords and related to soil erosion, control practices, and agricultural land was used (Table 2). Two duplicate articles were removed using Endnote X9 © 2018 Clarivate. The second phase is the screening. This phase included the records after duplicates were removed, and records were screened and excluded (Sierra-Correa & Kintz, 2015). At this phase, out of 4593 articles eligible to be reviewed, a total of 2135 articles were removed. The third phase is eligibility that shows full-text articles assessed and excluded (with reasons) such as i) the article did not focus on soil erosion control practices in Asian agricultural land; ii) the control practices proposed is not to be applied in agricultural land; iii) the control practices been proposed is not to mitigate soil erosion but for other reasons such as for improving soil water infiltration and to control pollutant from soil erosion; iv) soil erosion happened because of wind factor. A total of 380 articles was excluded in this phase. The last phase of the systematic review procedure resulted in a total of 39 articles that were used for the qualitative analysis. The selected articles are the articles that i) focus on the technique of controlling soil erosion in the agricultural field; ii) research done proved that the practices are suitable to be applied in agricultural land; iii) soil erosion that happened is associated with rainfall, farming practices, and topography.

3. Result

The systematic review resulted in three main themes and 11 sub-themes related to soil erosion control practices. The three main

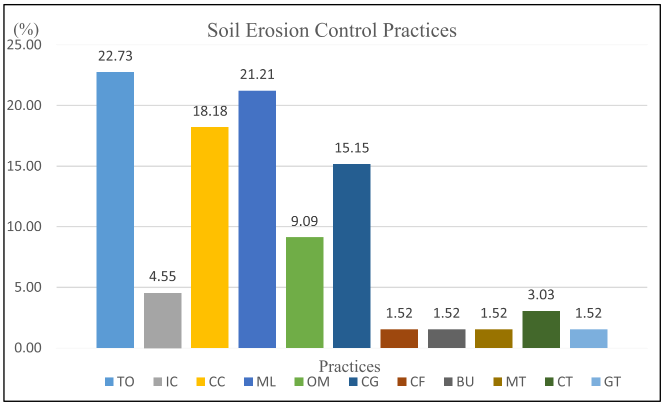

Fig. 2. Research on soil erosion control practices in Asia's agricultural land.

themes are agronomics practices, agrostological practices, and mechanical practices. Agronomics and agrostological practices are both considered as a biological method. The 11 sub-themes are tillage operation, intercropping, cover crop, mulching, organic matter, cultivation grass, contour farming, bunds, micro basin tillage, contour terrace, and geo-textile. The result (Refer Fig. 2 and Table 3) clearly shown that tillage operation and mulching dominate the type of conservation practices that are used to control soil erosion. Fig. 2 shows that tillage operation is the highest control practices being tested for the past six years (22.73%), followed by mulching (21.21%), cover crop (18.18%), cultivation of grass (15.15%), and others control practices.

A total of 23 studies concentrated in China on soil erosion control practices (Dai et al., 2018; Fan et al., 2015; S. F.; Guo et al., 2019; J.; Huang et al., 2016; J.; Huang et al., 2014; Z.; Huang et al., 2019; Mo et al., 2019; Li et al., 2018; Li et al., 2019; Lingling et al., 2014; Liu et al., 2014; Pan, Gao, et al., 2017; Pan, Song, et al., 2017; Pan et al., 2018; Rahma, Warrington, & Lei, 2019; Sui et al., 2016; Tang et al., 2015; L.; Wang, Dalabay, Lu, & Wu, 2017; L.; Wang et al., 2019; Q.; Wang et al., 2018; Y.; Wang, Dalabay, et al., 2017; Xu et al., 2018; G. H.; Zhang, Xie, Pi, & Zuo, 2015; Q.; Zhang, Liu, Cheng, & Huang, 2016), six studies focused on soil erosion control practices in South Korea (Ahn, Choi, & Kim, 2016; Ahn &

Table 3
Results.

Authors/countries	Practices										
	Agronomics practices					Agrostological practices	Mechanical practices				
	TO	IC	CC	ML	OM	CG	CF	BU	MT	CT	GT
L. Wang et al. (2019) – China	✓			✓							
Rahma et al. (2019) – China				✓							
Mo et al. (2019) – China						✓					
S. F. Guo et al. (2019) – China	✓										
Li et al. (2019) – China	✓										
Singh et al. (2019) – India			✓			✓					✓
Dai et al. (2018) – China	✓		✓	✓							
Li et al. (2018) – China	✓				✓						
Pan et al. (2018) – China				✓							
Q. Wang et al. (2018) – China						✓					
Xu et al. (2018) – China										✓	
Rasoulzadeh et al. (2018) – Iran				✓							
L. Wang, Dalabay, Lu, and Wu (2017) – China	✓										
Pan, Gao, et al. (2017) – China			✓			✓					
Pan, Song, et al. (2017) – China			✓			✓					
Y. Wang, Cao, et al. (2017) and Wang, Dalabay, et al. (2017) – China		✓		✓	✓						
Lenka et al. (2017) – India			✓								
Singh et al. (2017) – India			✓		✓						
Sharma et al. (2017) – India		✓									
J. Huang et al. (2016) – China			✓			✓					
Q. Zhang et al. (2016) – China	✓			✓	✓						
Sui et al. (2016) – China									✓		
Ghosh, Dogra, et al. (2016) – India	✓			✓	✓	✓					
Ghosh, Meena, et al. (2016) – India	✓			✓	✓	✓					
Ahn & Kim et al. (2016) - South Korea	✓			✓							
Ahn, Choi, & Kim. (2016) - South Korea	✓										
Choi et al. (2016)- South Korea				✓							
Maharjan et al. (2016) - South Korea			✓								
Won et al. (2016) – South Korea				✓							
Choi Y., Won, Shin, Park et al. (2016) - South Korea	✓										
Satriawan, Fuady, & Mayani (2017) – Indonesia			✓								
Fan et al. (2015) – China							✓				
G. H. Zhang et al. (2015) – China						✓		✓		✓	
Tang et al. (2015) – China	✓										
Eshel et al. (2015) – Israel			✓								
Satriawan et al. (2015) – Indonesia	✓	✓	✓								
J. Huang et al. (2014) – China			✓			✓					
Lingling et al. (2014) – China	✓			✓							
Liu et al. (2014) – China				✓							

Agronomics practices		Agrostological practices	Mechanical practices	
TO = Tillage operation	ML = Mulching	CG = Cultivation of grass	CF= Contour farming	CT = Contour terracing
IC = Intercropping	OM = Organic matter		BU = Bund	GT = Geo-textile
CC = Cover crop			MT = Micro basin tillage	

Kim, 2016; Choi et al., 2016a; Choi et al., 2016b; Maharjan et al., 2016; Won et al., 2016), six studies focused on soil erosion control practices in India (Ghosh, Dogra, et al., 2016; Ghosh, Meena, et al., 2016; Lenka et al., 2017; Sharma et al., 2017; Singh, Deshwal, Sharma, Ghosh, & Bhattacharyya, 2019; Singh et al., 2017), one study in Iran (Rasoulzadeh, Azartaj, Asghari, & Ghavidel, 2018), one study in Israel (Eshel et al., 2015) and two study in Indonesia (Satriawan, Fuady & Mayani, 2017; Satriawan, Harahap, Rahmawaty, & Karim, 2015).

3.1. Tillage operation

There is a total of 15 studies that focus on tillage operation in a way to control soil erosion in the agricultural area. From the field experiment been done by S. F. Guo et al. (2019) in sloping farmland hilly regions of Southern China, the result indicated that compared to the downslope tillage practices, cross ridge tillage reduced the average annual runoff by 6.11%–64.2%. Dai et al. (2018) have also used downslope tillage and contour ridge tillage in the field study in Southern China to reduced soil erosion in farmland. In both tillage plot, the runoff was reduced under heavy rainfall by 10% for downslope tillage plot and 49% for contour ridge tillage plot. Satriawan et al. (2015) have tested ridge tillage practices for three major crop plantations in Indonesia, which are oil palm, cocoa, and areca. As a result, in the cocoa plot, a combination of ridges with groundnut as a cover crop produced the lowest erosion, which is 8.20 t/ha. While in the areca plot, the implementation of ridges and maize produced the lowest erosion which is 4.64 t/ha. In the oil palm plot, ridge and maize treatment produced the second-lowest erosion which is 12.33 t/ha.

According to the study done by L. Wang et al. (2019), combining different tillage operations with few mulching techniques gave out a satisfying result. The practices that they used are conventional tillage with straw removal, conventional tillage with straw returning, reduced tillage with straw removal, and reduced tillage with straw returning. The reduced tillage with straw returning has the lowest mean annual runoff (90 ± 50 mm) from the averaged overall experiment's years compared to the other three practices.

The no-tillage practice is also one of the most popular tillage operations to control soil erosion. The no-tillage practice is a practice that keeps the natural physical soil properties of the whole soil layer that allows microbial and biotic activities to increase the infiltration, bulk density, wilting point and field capacity (Ahn & Kim, 2016). From the field experiment been done by Ahn, Choi, & Kim, 2016 in one of the South Korean agricultural areas showed a decrease in the runoff ratio by 10.5% for the no-tillage plots. In another study done by Ahn and Kim (2016), there are 22.5% reductions in the runoff ratio in the no-tillage plot, which is only 19.4% compared to 41.8% in the conventional tillage plot. While the study was done by Choi Y., Won, Shin, Park et al., (2016) , the runoff ratio of the no-tillage plot decreased by 64.9% compared with the conventional plots.

In a rain-fed agricultural area of China, data from a rainfall simulation on soils showed that cumulated infiltration was significantly increased, and runoff was decreased from no-till practices that combined with stubble retention. The soil erosion loss from the erosion was reduced by 62.4% (Lingling et al., 2014). Tang et al. (2015) experimented with testing the relationship between soil erosion and three tillage practices with subtropical monsoon climate in the Hilly Purple Soil area in China. The three tillage practices are minimum tillage, conventional tillage, and seasonal no-tillage ridges. The result showed that seasonal no-tillage ridges practices reduced the soil erosion and surface runoff amount compared to the other two tillage operations. The percentage of the micropores can be increased in the soil from the no-tillage practices. Thus, this situation will reduce runoff and enhancing the infiltration process. Ghosh, Dogra, et al. (2016) and Ghosh, Meena, et al. (2016) have practiced the minimum tillage method for their studies in India. The minimum tillage is a process of 50% tillage reduction. The mean soil loss and runoff from the field experiment in both studies decreased by practicing the minimum tillage method that been combined with proper nutrient management and a vegetative barrier.

Li et al. (2019) tested different surface roughness effect on soil loss produced by four different tillage operation which are contour drilling (uses a 'Lou' plow to create furrows and soil ridges), artificial digging (manual farming using narrow hoe), manual hoeing (broad hoe to cultivate soil) and contour plowing (uses a single plow to prepare a fine sowing bed and creates no furrows). The results showed the random roughness of surfaces with different tillage practices were ranked as contour drilling > artificial digging > manual hoeing > contour plowing > no-tillage control. From the experiment also, it can be concluded that the reduction effect of surface roughness on soil erosion decreased with increasing slope gradient, leading to increased soil erosion. In other studies, L. Wang, Dalabay, et al. (2017) did a research study on the effect of tillage practices on runoff and soil erosion from the Loess Plateau, China. Four types of tillage being tested to control erosion which is contour plow (traditional manual tillage using 'Lou' plow), artificial digging (manual farming using narrow hoe), artificial hoeing (traditional manual tillage using long-handled hoe) and traditional plow (traditional tillage using a single plow). Artificial digging, artificial hoe and contour plow is the most suitable as a summer tillage practices to control erosion because it delayed the time of runoff, decreases runoff and sediment and increase infiltration.

3.2. Intercropping

Intercropping is a practice of growing more than one crop in the same field simultaneously. In this practice, there is one main crop and one or two subsidiary crops. In Krueng Sieumpo, Indonesia, three major crops were tested with interplanting conservation methods to control soil erosion. The crops are areca, cocoa, and oil palm. The results show that ridges + groundnut most effectively reduce erosion on the land use of cocoa, ridges + maize effectively minimize erosion on the areca land use, and *Mucuna bracteata* is more effective in the oil palm land use (Satriawan et al., 2015). Y. Wang, Cao, et al. (2017) and Wang, Dalabay, et al. (2017) did a study on the effectiveness of the interplanting method on a hilly red soil region of China. The plot experiments were planted with orange trees together with peanut. The result indicated that the orange-peanut intercropping increased the resistance of soil to concentrated flow erosion. In the Himalayan Mountains agricultures area are more vulnerable to soil erosion because of the steep slope. A field experiment was conducted by Sharma et al. (2017) to tackle this issue using intercropping practices. The field experiment was conducted with six treatment combinations of maize crops in the rainy season (June–September) followed by the succeeding crop of the rainfed wheat crop in the winter season (November–April). Cowpea and okra were used as the intercropping crop. The result showed that the runoff and soil loss decreased by 26% and 43% respectively by including one row of cowpea or okra in between two rows of maize.

3.3. Cover crop

A cover crop canopy can reduce the soil erosion from cultivated fields during the peak season. The adequate ground cover canopy protects the land like an umbrella. The cover crop consists of sowing of legume and edible crop, which will provide a ground cover that can reduce raindrop impact, reduces water velocities, decreases runoff, and increases water infiltration in the soil. Therefore, cover crops are one of the ways to reduce soil erosion. Dai et al. (2018) used daylily as a groundcover that being planted in two hedgerows on a downslope tillage treatment plot. As a result, the runoff depth was reduced by 37%.

Besides daylily, white clover also acts as an excellent ground cover. Pan, Gao, et al. (2017) used white clover vegetation filter strip (VFS) in an experimental plot to see the ability of the VFS together with the white clover as an agricultural best management practice. The experiment showed that a white clover vegetation filter strip has a good soil infiltration capability and excellent runoff trapping capacity. White clover has also been used as a cover crop in Pan, Gao, et al. (2017) and Pan, Song, et al. (2017) study at Chinese Loess Plateau jujube orchard. The result showed that white clover is a good ground cover. The white clover treatment has the lowest runoff coefficient compared to the other treatment being tested in the study. Other than that, in the simulation study done by J. Huang et al. (2016) in sloping ground jujube orchards, white clover has also been used as a cover crop. The ground cover percentage under white clover cover was the largest in all growth periods caused that the annual mean time to a runoff under white clover cover was the largest and significantly larger than under other treatments (J. Huang et al., 2016). In the study done by J. Huang et al. (2014) for pear-jujube orchards, white clover cover has increased the infiltration of water amount and soil moisture. From these two studies (J. Huang et al., 2014; J. Huang et al., 2016) shows a good sign because as the time to runoff is high and the infiltration of water amount increased, the chances of soil erosion to occur will be lower.

In Haean catchment South Korea, sediment from the agricultural area been transported to the water bodies because of soil erosion. Maharjan et al. (2016) used winter cover crops together with split fertilization practices in their study as a control practice to reduce the amount of sediment yield from four major drylands crops (cabbage, potato, radish, and soybean). The cultivation of cover crops showed significant reductions of sediment yield compared to conventional practice. Eshel et al. (2015), used a different type of cover crops to see the impact of each cover crop in potato cultivation in Israel regarding the effects of the cover crops towards soil erosion, runoff and weed suppression. Five treatments plot were built consists of oats, triticale, oats with purple vetch, clover, and rapeseed as a cover crop in potato agricultural site. The overall result shows that under the cover crops treatments, soil erosion, and runoff reduced by 95% and more than 60%, respectively. Among the five cover crops, oats are the most efficient cover crop. In Indonesia, Satriawan et al. (2017) used *Mucuna bracteata* as a cover crop. The result showed the combination treatment of upland rice planted sequentially with soybean + strip *Mucuna bracteata* as a cover crop in oil palm crops (age 7–25 months, at 15–25% slopes) efficiently reducing the rate of runoff and prevent soil erosion from happening. There are also few other cover crops been used as soil erosion control practices in past studies such as birdsfoot trefoil and crown vetch.

3.4. Mulching

As can be seen in Table 3, many studies applied mulching techniques to control soil erosion. Mulch is any material, organic or inorganic in nature, like sawdust, straw, paddy husk, groundnut shell, crop residues, leaves, paper, and stones that can be spread on the surface of the soil. Therefore, it is protected from raindrop impacts, evade surface crusting, reduce evaporation, and in this manner conserve soil moisture. Pan et al. (2018) used chipped branches as a mulch in a plot-scale soil bin experiment to test the efficiency of this technique to control soil erosion in the agricultural area. Five treatments were tested, which is bare soil without mulching and four different rates of mulching with chipped branches (pruned branches), which is 0.37, 0.74, 1.11, and 1.48 kg m^{-2} under two representative rainfall regimes (light rainfall and heavy rainfall). The plot with mulching application reduced runoff by 15.5% and sediment yield by 40.7% compared to the bare soil without mulching applied.

From field experiment done by L. Wang et al. (2019), by combining reduced tillage practices with straw returning as mulching has significantly increased soil water content in the 0–10 cm soil depth. This situation showed that the rate of infiltration is high and lower in the rate of runoff. Dai et al. (2018) tested straw mulching in their study. The result showed that the runoff depths under heavy rainfall and sediment yields were reduced by 81% and 97%, respectively. Y. Wang, Cao, et al. (2017) and Wang, Dalabay, et al. (2017) used rice straw mulch at a rate of 5 t/ha^{-1} as control practices at a peanut field in China. They also tested a few other treatments, but the rice straw mulch treatment showed the lowest average soil detachment rate among all treatments which is 0.016 kg s^{-1} m^{-2}. Lui et al. (2014) conducted an experiment in the citrus orchard using straw mulching practices, and the result showed that the surface runoff is lower when the soil is covered with straw mulch compared to the unmulching soil. Rahma, Warrington & Lei tested the effect of wheat straw mulch rate on the total runoff, and total soil losses from 60-mm simulated rainstorms were assessed for two intensive rainfalls (90- and 180-mm h−1) on three slope gradients typical conditions on the Loess Plateau of China and elsewhere. They evaluated the efficacy of applying mulch to reduce soil and water losses from cultivated soils with three different textures exposed to intensive rainfall conditions. The result showed that with an optimal mulch rate depending on the slope, soil type, and rainfall intensities, the rate of erosion could be reduced.

In South Korea, Won et al. (2016) tested rice straw with polyacrylamide (PAM) and gypsum as mulch in an experimental plot that being cultivated with Chinese cabbage. The total runoff ratio reduces by 29.4% compared to the control plot, even the plot with mulching techniques in a more stepper slope. Choi et al., 2016 prepared three different treatment plots in the sloping agriculture field in South Korea. The three management practices are straw mat mulch, straw mat mulch + gypsum, and straw mat mulch + gypsum + PAM. As a result, the straw mat mulch + gypsum + PAM treatment plot showed the highest reduction effect for runoff. The mulching technique has also been tested in sandy loam soil at the upland crop area in South Korea (Ahn & Kim, 2016). By using rice-straw mulching practices, the results of field experiments on the slopes of 3% and 8% for radish and sesame cultivation had decreased for runoff ratio and sediment lost by 9% and 95.9% respectively.

In the semi-arid region of Iran, three treatments were tested to see the effects of the treatments on soil loss and surface runoff (Rasoulzadeh et al., 2018). The treatments are burning plant residue on the field, returning residues unto the soil surface after harvesting (mulching), and removing plant residues from the soil surface (control treatment). The result showed as compared to the control treatment, soil loss decreased by 96.5% in the returning residues unto the soil surface after harvesting treatment but increased by 192% in the burning plant residue on field treatment. The effectiveness of returning residues unto the soil surface after harvesting treatment also proved when the runoff volume reading is the lowest compared to the other two treatments.

3.5. Organic matter

There six studies that used organic matter to control soil erosion rate. Organic matter can be derived from the manure application or organic fertilizer. Manure decomposition has high organic matter content because of the manure decomposition. Y. Wang, Cao, et al. (2017) and Wang, Dalabay, et al. (2017) used organic manure fertilizer, which is fresh pig manure in research to reduces the soil erosion rates in the Red Soil Region of China. As a result, the treatment plot with the manure application has a low detachment rate, and this is because of the high organic matter content that makes it more resistant to detachment in the soil. Manuring can enhance soil aggregation that will improve soil structure. Therefore, this will reduce soil erosion rates. The combination use of organic matter with other soil erosion control practices can reduce soil loss in regions with intense agricultural activity (Q. Zhang et al., 2016). Li et al. (2018) suggested from their research that manure application in combination with seasonal fallow reduces soil erosion.

In the research done by Q. Zhang et al. (2016), the application of organic matter was used together with contour tillage, and straw mulching practices to control soil erosion. The runoff depth reduced by 19% and 50% in two treatment plots (contour tillage + organic matter and contour tillage + organic matter + straw mulching). The soil erodibility values under the two-treatment plot also decrease respectively by 14% and 30%. Ghosh, Dogra, et al. (2016) used farmyard manure and poultry manure in a few treatment plots for maize and wheat crops that combine with other control practices to increase the organic matter in the soil. The reduction of runoff and soil through bio-resources (farmyard manure and poultry manure) from this study is expected as carbon input from organic matters helps in the formation of more water stable macro-aggregates. Singh et al. (2017), tested different organic matter effect towards soil conservation of maize-wheat rotation agriculture field in north-western Indian Himalayas for seven years. Seven experiment plots were set up which are control (0), 100% NPK through inorganic fertilizers (100-0), 100% N through farmyard manure (FYM) (0–100), substitution of 50% N through four different organic manures viz., FYM (50 + 50 FYM), vermicompost (50 + 50 VC), poultry manure (50 + 50 PM) and in-situ green manuring (50 + 50 GM) of sunnhemp (*Crotalaria juncea L.*). The result showed the least runoff and soil loss values were observed with 50 + 50 (GM) in all the years.

3.6. Cultivation of grass

Cultivation of grass is one of the agrostological methods that suitable to apply in eroded agricultural land. Few types of grass and non-edible plant been used to control soil erosion in agricultural land. Ten studies use the agrostological method as a method to control soil erosion. Q. Wang et al. (2018), tested the effect of two types of grass hedges (Melilotus hedges; Pennisetum hedges) on runoff loss under different rain intensities and slope gradient on a maize field. Both of the grass hedges decreased surface runoff by 27%–72%. According to Q. Wang et al. (2018), the Pennisetum grass showed better efficacy compared to Melilotus grass, especially under high rain intensity. G. H. Zhang et al. (2015) used Bahia grass that planted in two ways as a soil erosion control practice. The first way is the citrus trees and Bahia grass was planted on the rain-fed terrace bed. The grass was planted on the bunds. Secondly is the horizontal terrace of orchards with Bahia grass planted on the riser (10%–50% vegetation cover). The result showed that the Bahia grass planted on the riser and bunds is a useful method for soil erosion conservation on sloping red soil land in China.

Four studies use cocksfoot grass as vegetative cover in China to control soil erosion (Pan, Gao, et al., 2017; J.; Huang et al., 2016; J.; Huang et al., 2014; Pan, Song, et al., 2017). All four studies use the vegetative filter strip method to plant the cocksfoot. From the four studies, Huang et al. (2016) and Huang et al. (2014) concluded that cocksfoot seemed to best the best vegetative ground cover for rainfed sloping jujube orchards and in pear-jujube orchards on dry slopes respectively. Mo et al. (2019) used Bermuda grass to reduce the amount of runoff in sloping citrus land, Southern China. They carried out four runoff plot experiment: (i) no vegetation, bare land (BL); (ii) conventional treatment, citrus without grass cover (CK); (iii) citrus with strip planting of Bermuda grass (SP); (iv) citrus with full cover of Bermuda grass (FC). Results showed that the annual runoff volumes were significantly ($P < 0.05$) reduced using SP (27.2 mm) and FC (33.0 mm) compared with CK (311.4 mm) and BL (456.7 mm) treatments (Mo et al., 2019).

In India, two studies used Palmarosa grass and Panicum grass as a vegetation strip in terms of controlling soil erosion. In both studies (Ghosh, Dogra, et al., 2016 & Ghosh, Meena, et al., 2016), cultivation of Palmorasa as vegetative barriers along with organic amendments, weed mulch application and minimum tillage is effective in decreasing runoff and soil erosion. Results also show an improvement in soil quality and an increase in soil system productivity.

3.7. Mechanical method

From the systematic review procedure, there are only a few studies that adapted the mechanical method as a way to control soil erosion. The first mechanical method is terracing contour. Terracing is a process of dividing the long slope into more short slopes. Therefore, there will change in the landform and reduces the slope gradient. As a result, the amount of soil erosion and the runoff amount and rate will be reduced. Xu et al. (2018) studied the effect of terracing on runoff and erosion in the Three Gorges area, China. Four experimental plots were set up consists of terraced orchard (3°), terraced cropland (3°), unterraced orchard (25°), and unterraced cropland (25°). The results show the average runoff coefficient of the terraced plot (orchard and cropland) was decreasing by 47.2% compared with the unterraced plot, and the average erosion rate of the terraced plot was reduced by 83.9% compared to the unterraced plots. Narrow terraces are also one of the terracing methods being implemented to control soil erosion in agricultural land.

In the Black Soil Region of Northeast China, a plot experiment was conducted to assess the effect of micro basin tillage as a mechanical method to control soil erosion in agricultural land (Sui et al., 2016). Results indicate that by using micro basin tillage, runoff and sediment rate reduced by 63% and 96%, respectively. G. H. Zhang et al. (2015) applied a level terrace on an experimental site together with bunds build on the outer edge of the terrace. Another treatment plot consisted of horizontal terraces of an orchard with a Bahia grass planted on the riser. The result indicated that surface runoff and soil erosion the two experimental plots were less than the control plot (bare land).

In India, Singh et al. (2019) used agro-geo-textiles in sloping croplands of the Indian Himalayan region as a soil conservation practice. Seven treatments have been tested during two years of experiment. Field experiments were conducted on zero tilled maize, minimum tilled garden pea and wheat crops planted in rainy, autumn, and winter seasons. Different vegetative filters and agro-geo-textile were used in the treatment. Cowpea cover crop and grass weed acted as a vegetative filter between the maize row. While maize straw, *Arundo donax* (giant cane), and coir as geotextile between the maize row. The result showed that conservation tillage together with *Arundo donax* geotextile reduced runoff by 24% and soil loss by 8.22 t ha^{-1} compared to only conservation tillage practice.

Contour farming or also called contour cultivation, is also one of the conservation ways of agriculture. Farmers will plant the crops across a slope by following its elevation contour lines. Soil erosion rate will be reduced by practicing contour farming in agricultural land because the arrangement of plants will break up the flow of water and increase the rate of infiltration. Fan et al. (2015) tested contour hedgerows farming to control soil erosion on sloping land in the Three Gorges Reservoir Region, China. They built few experimental plots of rows mulberry on a contour hedgerow with a mustard-corn rotation and one control plot (no mulberry hedgerow with mustard-corn rotation). The result shows that by planting mulberry in a contour hedgerow, the amount of runoff and soil erosion significantly reduces compared to the control plot, which adapts a conventional practice (no hedgerows).

4. Discussion

This study has attempted to systematically analyze the existing literature on control practices of soil erosion in Asia agricultural land. Heavy perception, intensive farming, and topography have led to soil erosion that needed to be controlled. A rigorous review sourced from the Web of Science and Scopus has resulted in 39 articles related to research on soil erosion control practices in Asia agricultural land. Three themes and 11 sub-themes emerged within the scope of this review. This review shows that the research on control practices that been adapted in Asia between the year 2014 until 2019 are more focused on the biological method rather than the mechanical method. The biological method consists of agronomics practices and agrostological practices. Tillage operation and mulching are the most control practices been used and suggested in the year 2014 until 2019 to control soil erosion in Asia agricultural land. Asian region itself consists of a variation of climates such as tropical, subtropical climate, Mediterranean, and temperate climate. Thus, this discussion will be divided according to the country in the result focusing on climate regimes.

China is one of the biggest countries in the world. Some parts of China fall under tropical, sub-tropical, and temperate climate. Therefore, the control practices being applied in China to control soil erosion are varied. According to the systematic review that has been done, most research in China about soil erosion control practices in agricultural land is located in the wet sub-tropical area. In the wet sub-tropical area, many control practices have been applied because of the seasonal variation. Some places will be planted with different crops in winter and summer. Tillage operation is the most favorable techniques to be tested to control soil erosion in agricultural land. In China, modern research on conservation tillage, such as no-tillage started to get attention as an effective way for reducing soil erosion, and this explains the big number of articles from China in the past six years. The conservation tillage (no-tillage) has lots of benefits that gain acceptance in many parts of the world in terms of enhancing global sustainable agriculture (Kassam et al., 2012). The conservation tillage systems have many favorable effects on soil structure and have been reported in different soil types and climates (Oyedele, Schjonning, Sibbesen, & Debosz, 1999).

However, for no-tillage practices, the adaptability of the procedures may be different from one place to another based on the climate and other ecosystem conditions (Golabi, El-Swaify, & Iyekar, 2014). According to them, the no-tillage method is more management intensive and its success or failure depends on knowledge associated with the soil and other ecosystems conditions where no-tillage is practiced. Furthermore, it is being reported that the weather conditions in the growing season are vital in the success of no-tillage practices system (Wang, Cai, Hoogmoed, Oenema, & Perdok, 2006). From the report of Food and Agriculture Organization (2012), climate adaption benefits of no-tillage can be significant. According to the report, wheat grown under no-tillage practices was more resilient, leading to yield increases over conventionally cultivated crops in the drought and high temperature in one of the Asian countries. Kargas, Kerkides, and Poulovassilis (2012) stated from their observation that an untilled plot retains more water than tilled plots. There are more stable aggregates in the upper surface of soils been associated with no-till soils than tilled soils and this resulted in high total porosity in no-tillage plot (Busari, Kukal, Kaur, Bhatt, & Dulazi, 2015). Therefore no-tillage is recommended for a high temperature area. From the systematic review, by practicing no-tillage and minimum tillage practices, proven that these practices can reduce soil erosion, improves soil structure, increases soil water infiltration, and conserves soil moisture. Other than that, ridge tillage practices also are suggested to be used to control soil erosion in China.

From all of the control practices being listed in Table 3 that being tested in China, mulching is also one of the popular methods. There are two types of basic mulch which are organic and inorganic mulch from the studies that been reviewed. Farmers need to consider which one is better to apply depends on the land use type and climate in Asia. Using an organic mulch will give more benefits to the plants because through time, organic mulches will slowly decompose and release nutrients into the soil and will improve the structure. Other than that, the organic mulch will keep the soil cooler and retain soil moisture levels, and this is suitable for a dry period in Asia. As in China, most of the wet sub-tropical areas will receive rainfall between April to September. Therefore, with the help of organic mulch to retain soil moisture levels in soil, this will help in the period of the low rainfall season. Organic mulch that often used in China is straw mulch.

Cover crop and cultivation of grass also play an important role in mitigating soil erosion in China. Cover crops and cultivation of grass have been used for a long time as one of the ways to control soil erosion. A very dense layer of the cover crop will reduce the speed of rainfall when it hits the ground and causing the soil not to splash. A cover crop will allow the soil to absorb water more efficiently because of the improvement in the water holding capacity and infiltration (Taguas et al., 2010) due to the abundant root networks of cover crops that keep soil firmly in place. Furthermore, ground cover such as legume, will not only reduce soil erosion through infiltration, reducing surface runoff, it also will increase the nutrient in the soil which is necessary for crop production since legumes are high in nitrogen. The cover crop and cultivation of grass usually being planted in a row or vegetative filter strip. It will be located between the main crop. In a heavier rainfall event, the plant covers significantly promoted infiltration compared with clear cultivation treatments (Pan, Song, et al., 2017). Therefore, this situation is really needed when the agricultural area in China subtropical area having a rainfall season.

However, some disadvantages using this method to reduce soil erosion such as the plant cover crop species may compete with the major crop planted for soil water and lead to declines in the yield of the major crops such as fruit plant (Pan, Song et al., 2017). Furthermore, the costs to implement cover crop as a conservation measure includes increased direct costs, potentially reduced income if cover crops interfere with other attractive crops, production expenses, difficulties in predicting nitrogen mineralization, and slow soil warming (Snapp et al., 2005). Additionally, a ground cover either cover crop or cultivation of grass will increase the cost for the commercial farmers. The ground cover must be planted at a time, therefore there will be an additional cost for planting the ground cover and then tiling it back under which means the farmers need to pay an extra cost for the labor and machinery. According to Swanson, Schnitkey, Coppess, and Armstrong (2018), at the farm level, establishing a cover crop will increases cost. From their research on an average Central Illinois farm, a cereal rye cover crop increases non-land costs by 5% from $563 to $591 per acre and the rye or vetch blend pushes non-land costs up to $621 which approximately above the baseline. From the analysis, cost increases because of the expenses of cover crop seed and the cost to drill it (Swanson et al., 2018).

Analysis from the systematic reviews shows less number of research on mechanical methods to control soil erosion in Asia agricultural land. The main control practices used under the mechanical method in China's agricultural land are terracing and contour farming. The basic function of terracing is the interception of water, which either absorbed or conducted slowly from the agricultural field, depending on the particular requirements of the locality (Nichols & Chambers, 1938). Xu et al. (2018) stated that climate change had only little influence on runoff and erosion in the terraced system. They also suggested that terracing will be more suitable to be applied in citrus orchard compared to cropland. Micro basin tillage also one of the treatments under a mechanical method that is suitable to be applied in China. It is a conservation practice that requires building individual earth blocks along the furrow (Sui et al., 2016). If this practice is being applied with an optimal block interval, it can be a useful practice not just to control soil erosion but also to control water loss and agricultural diffuse pollution (Sui et al., 2016).

South Korea is also one of the countries that are effectively doing research on soil erosion control practices. Most of the research about controlling soil erosion in South Korea focusing more on agronomic practices. South Korea has a sub-tropical and temperate climate. Therefore, soil erosion control practices must be suitable and able to perform well to mitigate soil erosion in their agricultural land. In South Korea, most farmers follow the traditional tillage practices for almost all crops they planted (Choi Y., Won, Shin, Park, et al., 2016). As years passing by, more research showed that conservation tillage could yield as much as conventional tillage and protecting the environment at the same time reducing soil erosion. From the systematic review, most research in South Korea about conservation tillage is about no-tillage practices. According to Choi, Choi, Lim, and Shin (2005), no-tillage method can be a suitable alternative to reduce soil erosion from the steep uplands in Korea if the crops cultivated are corn, soybean, wheat, and barley. However, in the high mountain alpine fields, the major crops are potato, radish, carrot Chinese cabbage and few other vegetables, moreover, those crop cultures need conventional tillage (Choi et al., 2005). Therefore, researchers and farmers need to consider other control practices and mulching is one of their options.

From the systematic review, rice straw mulch has always been the most frequently mulch used to protect the soil surface from being eroded. Rice straw mulch is an organic mulch and give lots of benefits to the soil. However, farmers need to consider that they may need to replenish the organic mulch frequently than the inorganic mulch because it will decompose. If farmers use the inorganic mulch such as plastic film and stone, it doesn't break down, and farmers can save time and money because inorganic mulch does not require regular replacement. From all the articles that used mulching as one of the techniques to control soil erosion, the rate of infiltration is increasing. There are studies shown that the infiltration rate has a positive relationship with the application rate of the mulch. The soil surface is protected from the rain impacts by the application of the mulch. This helps to retain the soil in the same place. There are also studies suggested to use mulch together with soil amendments in South Korea such as PAM and gypsum to help mulching to be more effective. PAM and gypsum will increase soil cohesion, reducing soil detachment and transport (Won et al., 2016). Thus, by combining the mulching technique with soil amendments, soil erosion rates can be reduced more efficiently. Although there is no recent research done about using the mechanical method in South Korea agricultural land to control soil erosion, but this method already been practiced in South Korea upland. Choi et al. (2005) suggested using a mechanical method such as terrace, sediment basin and trap, drainage ditch and channel, and grade stabilization structure on steep sloped upland in South Korea.

India is one of the countries facing a soil erosion problem in their agricultural land. India climate is ranging by most of the area is tropical, and some part is a sub-tropical and temperate climate. Like in every other country, tillage operation is the most considerable practice used to control soil erosion in India. Recent studies in India about tillage method are suggesting to use minimum tillage practices (Ghosh, Dogra, et al., 2016; Ghosh, Meena, et al., 2016). Minimum tillage is a 50% tillage activity reduction. They suggested combining minimum tillage with other control practices such as weed mulching, grass vegetative barrier, and the application of organic matter to see the effectiveness of the practices in subtemperate agricultural land. Studies show the implementation of the minimum tillage together with the addition of organic matter has enhanced soil aggregation process and water stable aggregates and decreased long term soil erosion on a gentle slope in the Indian Himalayas (Ghosh, Dogra, et al., 2016).

Li et al. (2018) refers to the ideas of Gholami, Sadeghi, and Homaee (2016) and Lalande, Gagnon, Simard, and Cote (2000) that organic matter such as manure application will enhance enzyme activities and microbial biomass reduces splash erosion and delays runoff and sediment concentration time. Farmyard manure is one of the organic matters that farmers used in India. Organic matter is an essential component of the soil that keeps the soil particles clumped together, and thereby this will create resistance against soil erosion. The presence of organic matter is a must for microorganisms to flourish in the soil. Microorganisms secrete some slimy substance which helps in binding together of soil particles. The more frequent farmers added the organic matter to the soil, a structural unit called aggregates would form from the synthesis of complex organic compounds that bind the soil particles. Rainfall will percolate and infiltrate better downward through the soil because these aggregates help in maintaining the open, loose, and granular condition. Therefore, this situation reduces surface runoff and at the same time the amount of soil erosion will be decreasing.

In the sub-tropical area of India, maize and wheat are important crops in their agricultural land. Planting a cover crop or as in-situ green manuring such as sunnhemp between maize or wheat brings lots of benefits. Sunnhemp can be grown as dual purpose, firstly as a green manure as well as fiber crop because after harvesting of fiber crop, the top portion (30 cm from the top) can be incorporated into the soil (Sarkar & Ghoroi, 2007) which substantially increase the yield of the major crop. By combining sunnhemp with inorganic fertilizers will lead to more conservation of natural resources, particularly soil of maize-wheat system in a longer period of years (Singh et al., 2017). Cover crop management practice also suitable in sloping agricultural land of north-eastern India. Under the cover management treatment with selective and controlled weed retention has resulted in lower soil loss. According to Lenka et al. (2017), using selective weed retention as cover management practices has brought to a cost-effective management strategy for conserving soil, water and plants nutrients on sloping lands of areas under shifting cultivation in the north-eastern region of India. They also suggested that this practice is suitable to be adopted by farmers who are experiencing similar soil erosion problems in the hilly area of tropical and sub-tropical areas because of the simple and low-cost technology.

Agro-geo-textiles cover is also one of the suitable control practices in India especially in the sub-tropical area. These practices not just effective in controlling soil erosion but also help in terms of economy. With proper management, mineral fertilizer applications can be decreased because of less runoff and soil loss (Singh et al., 2019). Not just that, by applying agro-geo-textiles treatment, it will be resulted in cost-effective in the long-term situation. Cost for a synthetic geotextile is very high compared to agro-geo-textiles such as maize straw and *Arundo donax* where can be found easily and abundantly available.

Indonesia is one of the biggest agricultural producers in the world and it falls under the tropical climate. There are varieties of crop in tropical areas such as oil palm and cocoa. For tropical area, cover crop plays an important role in order to minimize soil erosion. A cover crop that is planted in the intercropping system has lots of benefits towards the cropland. Satriawan et al. (2015) suggested that intercropping combined with ridges tillage is effective to reduce erosion and runoff at cocoa and areca land use. This is because ridges tillage will modify the soil surface to become more rugged and will collect more water to be stored in the soil (Satriawan et al., 2015) instead of becoming a runoff flow. The tropical area will receive rainfall throughout the year. Therefore, it is really suitable to use cover crops in Indonesian agricultural land because the cover crop will reduce the runoff rates from the rain erosivity through the interception process.

Oil palm is one of the very important crops in Indonesia and contributes lots to the Indonesian economy. Therefore, it is vital to know the control practices that need to be applied in the oil palm agricultural land. Usually in Indonesia, oil palm being planted on slope areas. The age of oil palm and land slope combined with soil conservation measures had a significant effect on soil erosion (Satriawan et al., 2017). The use of *Mucuna bracteata* as a cover crop really helps to reduce soil erosion in oil palm agricultural land. The dense root of *Mucuna bracteata* will bind the soil particles and gives more stabilization to the slope.

The climate in Iran is influenced by Iran's location, the climate is arid sub-tropical and wet sub-tropical. In semi-arid regions, soil erosion is one of the most important problems (Rasoulzadeh et al., 2018). According to Marques, Bienes, Jiménez, and Pérez-Rodríguez (2007), there is a clear relationship between soil erosion and rainfall in semi-arid regions which will lead to soil degradation. From the systematic review, a past study suggested to use a mulching technique which is returning plant residue to soil decreases soil erosion and soil loss by increasing soil organic matter content and decreasing surface runoff (Rasoulzadeh et al., 2018). The researchers stated that removing plant residue and burning it are the most common practices in the region and by burning them has negative impacts on soil physical properties and generate more soil erosion event. Therefore, they suggested returning the plant residue to soil because it has lots of benefits. According to Eshel and Egozi (2013), the soil loss rates under conventional agriculture in the Mediterranean climate is about 4–7 mm year^{-1}. In the central Israel Mediterranean coastal plain, the most common crop is potato, watermelon, carrot, sweet potato and cereals. The cover crop has been suggested to be used to mitigate soil erosion in the potato field (Eshel et al., 2015). According to Eshel et al. (2015), oat as a cover crop in potato field supplies efficient cover for the soil surface before the rainy season and allowing penetration into the soil, therefore indirectly lowering the quantities of surface water runoff and peak flow that will decrease soil erosion rate.

From Table 3, clearly shown that a smaller number of researches been done about mechanical method on soil erosion control practices in Asia agricultural land. There are more mechanical methods can be applied in the agricultural area to control soil erosion such as basin leaching, contour trenching, sub-soiling and ridging. Mechanical methods are designed to control soil erosion and runoff in agricultural land where biological control practices alone are insufficient to reduce soil erosion to permissible levels (Blanco & Lal, 2010). The construction of the mechanical method will change the agricultural landscape features and involves soil disturbance, while the biological method will not change the landscape and disturb the soil. Biological methods that consist of agronomics and agrostological practices are also less expensive than mechanical structures method. This might the reason for explaining the choices of the biological method compared to the mechanical method in Asia agricultural land. However, it is suggested to combine both biological and mechanical methods in the agriculture area to effectively reduce soil erosion rates.

In terms of economy, choosing the right control practices is really important. This is because, by choosing the right control practices with proper management can give a positive impact in terms of the economy.

5. Future direction and conclusion

This systematic review focusing on the last six years and the result shows that research on control practices to control soil erosion in Asia agricultural land focusing more on the biological method instead of the mechanical method. Therefore, it is suggested that the review efforts in the future will consist of a few points. Firstly, researchers can do a review of research related to mechanical methods to control soil erosion in Asia agricultural land with a longer time review period. Mechanical approaches such as terracing, micro basin tillage and fish-scale pits that used to mitigate soil erosion are proven effectively reducing the soil loss rate. 50 years of the review period will give a good picture and new insight into related stakeholders on how the mechanical method can help to control soil erosion. Next, researchers can also review the efforts and support from local government regarding financial management, training, and policies to control soil erosion.

This systematic review has highlighted the method and practices to control soil erosion in Asia agricultural land. Soil erosion is one of the main soil degradation phenomena that will threaten the environment sustainability and soil productivity, thus affecting food security. The interaction between rainfall regime, soil properties, vegetation covers, slope characteristics, and land use management will result in soil erosion. Soil erosion in the agricultural area is a severe problem that needs to be tackled from the root. Understanding soil erosion in the agricultural field is an essential step toward developing effective soil conservation strategies. From this review, it is clearly shown that tillage operation and mulching are the most preferable and proposed methods to be practiced in the agricultural area. Human being has an enormous duty to ensure food security for the present and future generations. Furthermore, they also have a great responsibility to reverse the soil degradation trends. In order to protect, maintain and improve the soil's productivity and environment, there is a need for high-level commitment in all sectors of society. By substantially decreasing soil loss, conservation practices will conserve the soil's fertility and allow the land to sustain higher crop yields that will have a positive impact on Asia's economy.

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