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REVIEW

Potato Farming in the United States and South Korea: Status Comparison of Cultivation Patterns and Agricultural Machinery Use

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Abstract

Purpose This study aims to compare and analyze the status of potato cultivation patterns and agricultural machinery use in the USA and South Korea. These results can be used to enhance the productivity and efficiency of potato cultivation in South Korea by improving the mechanization rate of potato farming.

Methods Multiple studies were conducted to collect data and compare the status of each country. Background information on the research and industry was collected through the literature review. On-site information such as mechanization status, main production areas, cultivation technologies, and efficiency was gathered by interviewing local farmers and visiting agricultural sites in both the USA and South Korea.

Results In the USA, the mechanization rate of potato cultivation has reached 100%, leveraging the efficiency of potato production through highly advanced mechanization based on large-scale agricultural systems. In contrast, in South Korea, owing to narrow farmland and geographical characteristics, the mechanization rate is low, and most potato cultivation relies on small agricultural machinery and manual labor.

Conclusions To enhance the productivity and efficiency of potato farming in South Korea, it is essential to develop small multifunctional agricultural machinery tailored to the country's geographical characteristics. This can be achieved by incorporating advanced agricultural technologies from the USA and standardizing the cultivation methods and machinery operation practices.

Keywords Agricultural machinery · Geographical characteristics · Mechanization rate · Potato cultivation · Standardization

Introduction

Potatoes are among the world's most important food crops, with annual global production exceeding 375 Mt. However, cultivation patterns and agricultural technologies vary significantly between countries. The USA, the world's fifth largest potato producer, produces approximately 20 Mt/year, with a production efficiency of 40 t/ha (FAO, 2022). In contrast, South Korea produces approximately 600,000 t annually, with a production efficiency of 20 t/ha, which is half that of the USA (KOSIS, 2022). The disparity in potato production between the USA and South Korea is largely due to differences in arable land availability, cultivation environments, and the use of agricultural machinery (Bokusheva & Kimura, 2016).

The USA maximizes potato production efficiency through mechanization systems based on large-scale agricultural operations, leveraging vast arable land and favorable

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climatic conditions (KREI, 2017). These mechanization systems significantly reduce labor and production costs (Peng et al., 2022). In contrast, the agricultural landscape of South Korea is characterized by relatively narrow plots and diverse climatic conditions. Potato farming is predominantly conducted on small and medium-sized farms, most of which own less than 3 ha of land. Additionally, the rural population is aging, and rural-to-urban migration causes labor shortages (Jung & Kim, 2023). Although South Korea is gradually integrating modern mechanization into traditional cultivation methods, it still lags behind the USA in terms of efficiency and scale (Ha & Chung, 2012; Yang et al., 2023).

In the USA, the mechanization rate of all potato cultivation processes is approximately 100%. The selling price of U.S. potatoes is approximately $0.25 per kg, significantly lower than the $2.5 per kg price in South Korea (Kim, 2024). Despite the low selling price, the high degree of mechanization in the U.S. has generated approximately $100.9 billion in revenue and created approximately 714,000 jobs by 2021 (Knudson et al., 2023). The standardization of farming machinery ensures compatibility and automation between tractors and attached agricultural machines, thereby facilitating mass production (Schmitz & Moss, 2015). In contrast, the mechanization rate for potato cultivation in South Korea will reach 72.4% by 2021, with specific rates varying across different processes: 99.5% for plowing and harrowing, 4.6% for planting, 83.6% for vinyl mulching, 97.3% for control, and 77.2% for harvesting (KOSIS, 2021). The low mechanization rate for planting, which is often done manually, and the use of common machinery for multiple crops, such as sweet potatoes, increase labor costs and overall cultivation expenses in South Korea. To address these issues, it is crucial to enhance the mechanization of potato farming in South Korea.

Previous studies have focused on analyzing potato agricultural policies across various countries. For instance, Sultana et al. (2023) surveyed Bangladeshi potato farmers to evaluate their economic and technical efficiency and examined factors such as cultivation area, production, labor costs, and production costs to suggest policy improvements. Saptana et al. (2022) compared potato production and costs between Indonesia and other countries, highlighting the challenges faced by Indonesian farmers compared to those in advanced agricultural nations and suggesting improvements to Indonesia's potato production and sales systems. Svubure et al. (2017) analyzed the impact of agricultural policies on potato production by evaluating changes in productivity and agricultural systems following Zimbabwe's land reform in 2000, offering insights into the effects of policy changes on potato production and future policy directions.

Although some studies have compared agricultural policies related to potato cultivation, studies comparing cultivation methods and the actual use of agricultural machinery are lacking. This study aimed to provide foundational data for mechanized agricultural technologies in the South Korean context by comparing and analyzing potato cultivation methods and machinery use in both countries. By learning from each country's application of agricultural technology and mechanization, this study seeks to enhance the mechanization rate of potato cultivation in South Korea, thereby improving agricultural productivity and efficiency.

Methods

The research method employed in this study involved a comprehensive literature survey using the SCOPUS and ScienceDirect databases. Agriculture-related data were gathered from multiple sources including FAOSTAT, USDA-NAS, KOSIS, national reports, and books. Additionally, on-farm information, including the main production areas of potatoes, cultivation technologies, and the status of mechanization throughout the cultivation process, was collected through field experience and communication with agricultural workers and industry members in South Korea and the USA. This diverse dataset was used to compare potato cultivation patterns and the use of agricultural machinery in both countries. This approach provides a robust foundation for analyzing the differences between the two countries and identifying potential improvements in the mechanization and productivity of potato farming in South Korea.

Previous Research

Recent literature and related research on the use of potato farming machinery are scarce, with most studies focusing primarily on potato planting and harvesting machines. This is because planting and harvesting operations are crucial stages in the potato cultivation process that affect both yield and quality, and they require the most labor. Zheng et al. (2021) compared the development status and mechanization levels of potato planting machines across different countries. They found that due to variations in economic conditions, cultivation systems, and geographic and environmental factors, there is an imbalance in the development and mechanization of potato planting machines. They also highlighted the need for improvements and advancements in potato planting machines to ensure their applicability in diverse environments. Zhou et al. (2022) reviewed recent technological trends and research progress in potato planting machines. They analyzed the features and mechanisms of the developed potato planting machine and evaluated the strengths and weaknesses of each. Additionally, they highlighted the need for the development of small and medium-sized as well as intelligent planting machines to advance the

mechanization of planting operations. Johnson and Cheein (2023) reviewed the latest machinery technologies used for potato harvesting operations worldwide. They projected that integrating automation and precision agriculture technologies into a potato harvesting machine would enhance productivity and reduce labor costs, and they proposed directions for future technological development. Parihar et al. (2024) reviewed the development status of a potato harvesting machine and analyzed factors affecting its performance to optimize it. They found that mechanical factors, such as the design and components of the potato harvesting machine and the foreign matter removal system, have the greatest impact on performance. To address these issues, they proposed integrating automation and precision control systems. Although studies comparing the usage of potato planting and harvesting machines have been conducted, there is still a lack of research on the usage and mechanization levels across the entire potato cultivation process.

Status of Potato Main Production Area

In the USA, potatoes are classified into spring, summer, and autumn varieties based on their harvest periods and are cultivated across 13 states (Idaho, Washington, Wisconsin, Oregon, North Dakota, Michigan, Colorado, Minnesota, Maine, Nebraska, California, Texas, Florida). Each region had different potato cultivation periods owing to varying climatic conditions. Most potatoes grown in the U.S. are russet varieties with production and cultivation predominantly focused on autumn (USDA, 2020). Consequently, the production of autumn potatoes was significantly higher than that of spring and summer potatoes, accounting for 18 Mt or over 80% of the approximately 22 Mt of the total U.S. potato production (Fig. 1a).

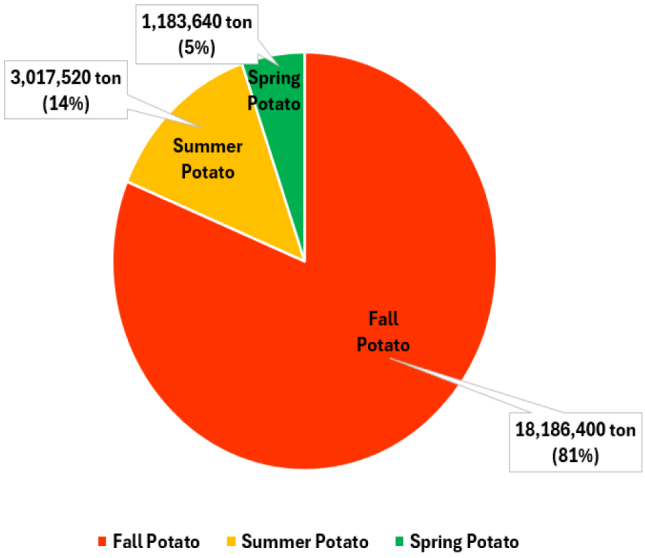
U.S. spring potatoes are primarily grown in southern states, including Florida, Texas, and California (Christensen et al., 2013), which experience relatively mild winters compared to the northern states. Although these three states have the lowest overall potato output, they produce the most spring potatoes in the U.S. Summer potatoes are cultivated in the central USA, with significant production occurring in Oregon, Colorado, and Nebraska. Other central and northern states such as Wisconsin also have small areas dedicated to summer potato cultivation. These potatoes are grown between spring and fall to meet consumption demands and produce seeds for autumn potatoes, which constitute the majority of potato production in the USA. Autumn potatoes are primarily grown in northern states. Seven of the 13 main production areas are in the northern U.S., including Idaho, Washington, North Dakota, and Minnesota. As of 2023, Idaho produced approximately 7.36 Mt, Washington produced approximately 5.06 Mt, and Wisconsin produced 1.49 Mt of potatoes. These three states account for approximately 62% of total potato production in the USA (Fig. 1b).

Similar to the USA, potatoes in South Korea are classified into spring, summer, fall, and winter varieties based on harvest period. The total production of potatoes in South Korea was 480,601 t. The autumn and winter potatoes accounted for approximately 11% of total production, yielding 52,906 t. In contrast, spring and summer potatoes in 2022 were 303,211 t and 124,484 t, respectively, constituting approximately 64% and 25% of the total potato production (Fig. 2a). The main production areas for spring potatoes were Chungcheongnam-do, Gangwon-do, Gyeongsangbuk-do, Jeollanam-do, and Gyeonggi-do, with production volumes of 48,599 t; 46,947 t; 46,590 t; and 46,461 t, respectively (Fig. 2b). The total production of summer potatoes was 124,484 t, with more than 99% of it produced in Gangwon-do (Fig. 2c).

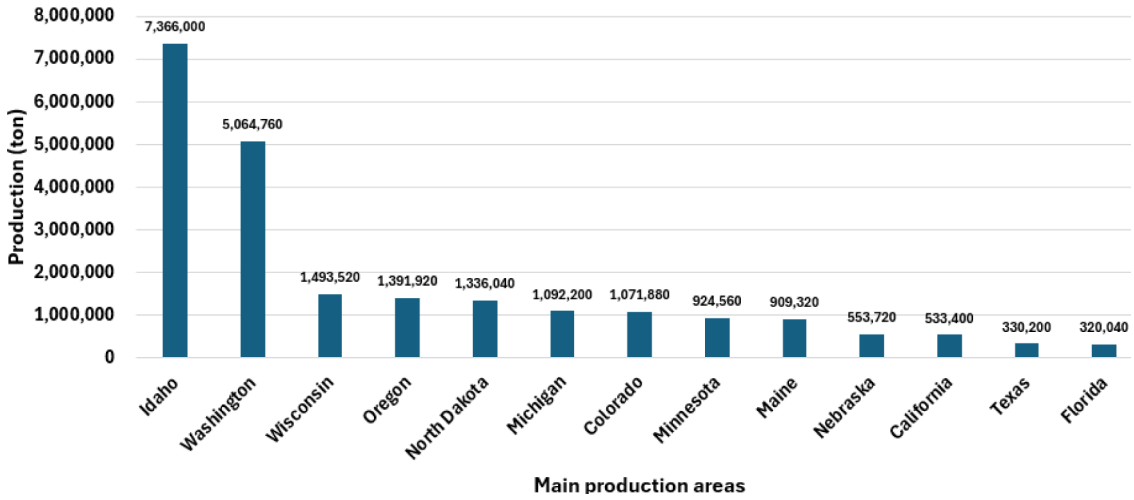
Status of Potato Cultivation Pattern

As shown in Fig. 3, potato cultivation patterns in the USA and South Korea were analyzed based on the cross-sectional view of the potato ridge. In the USA, potato cultivation patterns exhibit regional variations but follow a standardized approach overall. Most American potato farmers focus on growing russet potatoes due to their high commercial value. Customized farming machinery is used for the mass production of russet potatoes, leading to standardized cultivation practices tailored to the specifications of russet potatoes and the associated agricultural machinery (Leap et al., 2017). A notable cultivation method in the USA is the double-row method, where potatoes are planted in two rows within a single ridge. This method enhances efficiency, simplifies management, and promotes uniform potato growth in a mechanized agricultural environment (Singh, 2006). The specific cultivation patterns applied in the USA are detailed in Table 1, with a cross-sectional view illustrated in Fig. 3. The ridge width ranges from 600–700 mm, with a furrow width of 400 mm and a ridge height of 150–200 mm. The spacing between plants in the row and the planting distances are 400 mm and 300 mm, respectively (Li et al., 2024; Zhang et al., 2023).

Compared to the USA, South Korea exhibits distinct differences in temperature and regional characteristics across its main production areas, resulting in varying potato cultivation patterns. This comparison focuses on spring and summer potatoes, which constitute most of Korean potato production. The cultivation patterns for each type of potato are detailed in Table 2. For spring potatoes, predominantly grown in the central and southern regions of South Korea, the double-row method is commonly used. This method involves planting potatoes in two rows within a single ridge to maximize production and make efficient use of agricultural land. The



(a) Production by type of potato



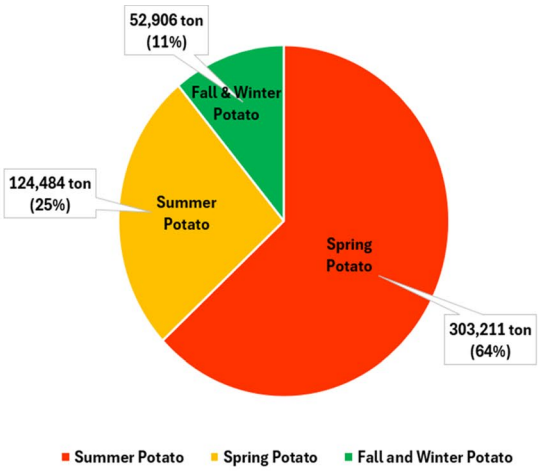
(b) Production by main production areas

Fig. 1 **a**, **b** Potato production in the USA

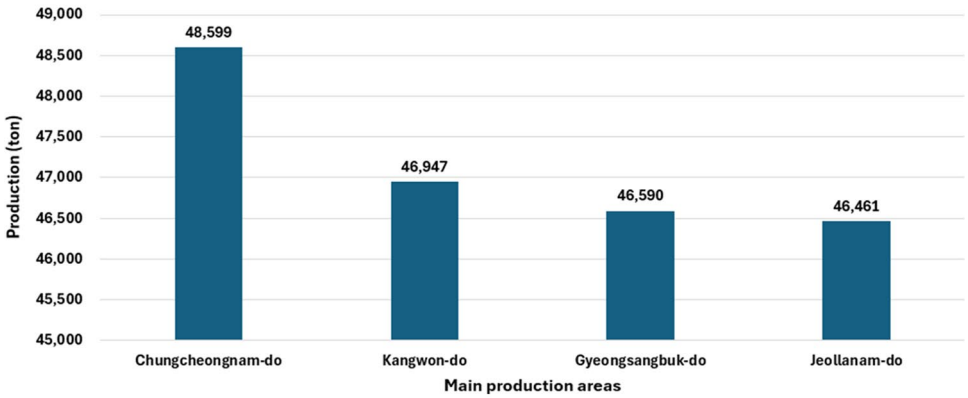
typical specifications for this double-row method are a ridge width of 800 mm, a furrow width of 500 mm, and a ridge height of 300 mm. The spacing in the row and planting distance are 320 mm and 320 mm, respectively. In contrast, small farms often use the single-row method, which features a ridge width of 500 mm, a furrow width of 300 mm, a ridge height of 300 mm, and spacing in the row and planting distance of 800 mm and 210 mm, respectively. Summer potatoes are cultivated in the highland areas of Gangwon-do, known for their altitude and steep slopes. Due to the narrow and steep nature of the land, these areas cannot be used as efficiently as flat land. Consequently, all summer potato cultivation employs the single-row method. The specifications for this method include a ridge width of 420 mm, a furrow width of 300 mm, a ridge height of 200 mm, and spacing in the row and planting distances of 720 mm and 250 mm.

Status of Potato Agricultural Machinery Use

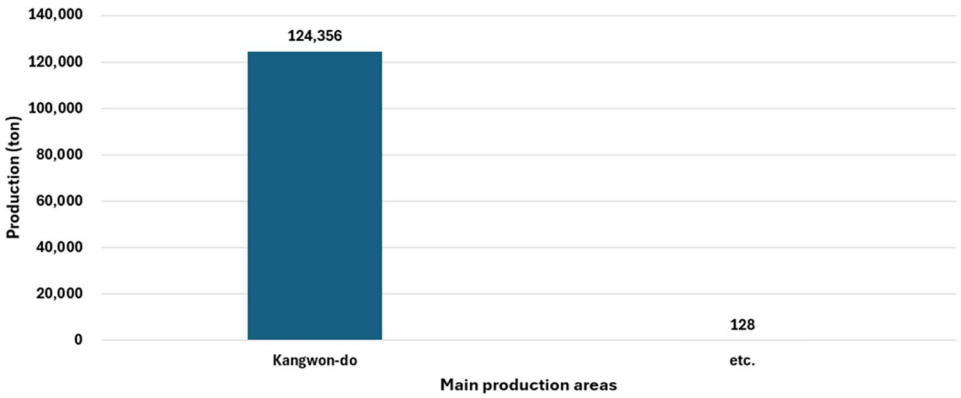
In both the USA and South Korea, potato cultivation processes are divided into preparation, planting, maintenance, and harvesting, although the detailed work processes differ between the two countries. In the USA, the mechanization rate for the entire potato cultivation process is 100%, with full automation implemented to maximize production



(a) Production by type of potato



(b) Production by main production areas of spring potato



(c) Production by main production areas of summer potato

efficiency and productivity. High mechanization is driven by the need to generate profits through mass production and to reduce production costs. Therefore, mechanization throughout the cultivation process is essential in the USA, whereas the mechanization rate in South Korea is significantly lower. This disparity is attributed to several factors, including the aging agricultural population, the high proportion of small and medium-sized farms, the high initial costs of agricultural machinery, and the challenges posed by topography (Koo & Kim, 2018). The aging population struggles to adopt new technologies and operate advanced machinery, and small and medium-sized farmers find it challenging to afford and maintain expensive equipment. In addition, large-scale machinery cannot be used efficiently in South Korea's narrow and complex agricultural landscapes. As a result, South Korea primarily relies on versatile agricultural machines that can

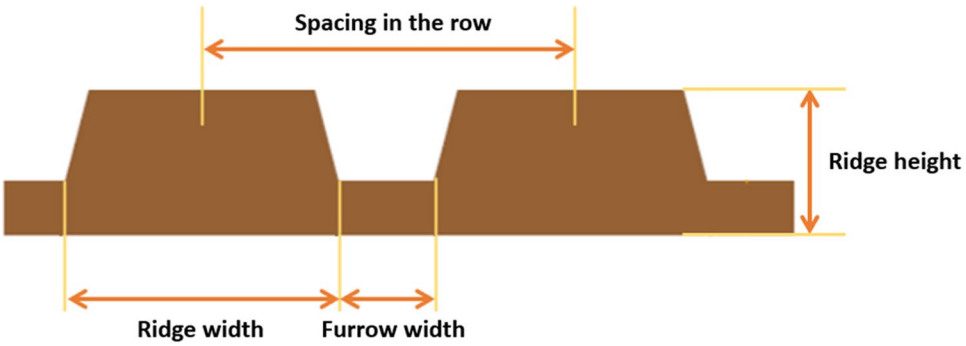


Fig. 3 A cross-sectional view of cultivation pattern of potatoes in the USA and South Korea

Table 1 Cultivation pattern of potato in the USA

Item	Cultivation pattern	Ridge width (mm)	Furrow width (mm)	Ridge height (mm)	Spacing in the row (mm)	Planting distance (mm)
All potatoes	Double row	600–700	400	150–200	400	300

Table 2 Cultivation pattern of spring and summer potatoes in South Korea

Item	Cultivation pattern	Ridge width (mm)	Furrow width (mm)	Ridge height (mm)	Spacing in the row (mm)	Planting distance (mm)
Spring potato	Single row	500	300	300	800	210
	Double row	800	500	300	320	300
Summer potato	Single row	420	300	200	720	250

be used for various crops or on smaller machines with walking managers and tractors (Kwon et al., 2014).

Preparation Process

In the preparation process, both the USA and South Korea perform tasks such as plowing, harrowing, and ridge-forming operations. However, South Korea employs an additional operation, namely, vinyl mulching. This operation is combined with ridge-forming operation and helps leverage potato production and improve quality, particularly in the context of narrow agricultural land (Im et al., 2016). In the USA, vinyl mulch is not used because of the focus on mass production with minimal labor and the consideration of harvest loss rates of potatoes (Hochmuth et al., 2018).

In the preparation process for the main production areas in the USA, tractors equipped with cultivation machines featuring plows and disk harrows are employed. American cultivation machines are designed to efficiently handle large areas of agricultural land, necessitating the ability to perform multiple tasks simultaneously. These machines typically have 6 to 12 tilling capabilities and may be equipped with a folding design for easy transportation, particularly for machines with 12 rows. Examples of key preparation machines used in the USA are listed in Table 3.

In South Korea, the preparation process for field cultivation is divided into several operations, including plowing and harrowing, ridge forming, and vinyl mulching. Plowing and harrowing a tractor-attached rotavator are commonly used to level the soil and break up large clumps, making it suitable for potato cultivation. The working width of the rotavator can be adjusted to accommodate the size of agricultural land. In Gangwon-do, a stone collector is used to remove stones from the soil before the cultivation of summer potatoes. After plowing and harrowing operations, further cultivations are performed to enhance drainage, ease harvesting, and improve potato quality (Vučajnk et al., 2012). Most farms use cultivators and tractor-attached ridge-forming machines that are selected based on a specific cultivation environment. The ridge-forming machine breaks up the soil using a cultivation blade at the front and forms a bed using a frame or disk at the rear. Examples of preparation machines used in South Korea are listed in Table 4.

Vinyl mulching operations in South Korea employ a cultivator-attached vinyl mulching machine that fits the narrow nature of agricultural land. Vinyl mulching requires manual labor to secure the vinyl by fixing both ends. However, recent advancements have allowed vinyl to be secured more efficiently using a disk attachment that simultaneously covers and secures the vinyl. In addition,

Table 3 Introduction of preparation machines used in the USA

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
9306–6 Row Cultivator/ Spudnik/ United States	Tractor-attached	* 	Over 300	6
LC40-1236/ Great plains/ United States	Tractor-attached	** 	Over 250	12
Nutri-Tiller 955/ Case IH/ United States	Tractor-attached	*** 	Over 450	12

*Source: Spudnik Home page, https://www.spudnik.com. **Source: Great Plains Home page, https://www.greatplainsag.com. ***Source: Case IH Home page, https://www.caseih.com

a tractor-attached vinyl mulch machine that performs both head molding and vinyl mulching was developed. However, this machine is not widely favored by farmers because of issues such as vinyl jamming, frequent malfunctions, and reduced work performance. Details of the vinyl mulch machines used in South Korea are listed in Table 5.

Planting Process

In the USA, most potato planting machines can perform ridge-forming, planting, and fertilizing operations simultaneously. These machines are typically tractor-attached and feature seed potatoes stored in a supply box, which are then transferred to the soil via conveyor chains and belts. The

Table 4 Introduction of preparation machines used in South Korea

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
HC215GL/ Daedong/ Korea	Tractor-attached	* 	Over 65	-
AF-300/ Asia Technology/ Korea	Cultivator-attatched	** 	-	1
DRB-1200V/ Dooroo/ Korea	Tractor-attached	*** 	Over 55	1
DPM-1700R/ Daepoong/ Korea	Tractor-attached	**** 	Over 50	2

*Source: Daedong Home page, https://www.daedongmobility.co.kr. **Source: Asia Technology Home page, https://www.asiakor.com. ***Source: Dooroo Home page, http://dooroo21.com. ****Source: Daepoong Home page, http://www.dpmc.co.kr

potatoes were then planted and covered with soil using a disk harrow, and the nutrients required for the potatoes were sprayed using a spraying system installed behind the planting machine. This method offers a higher planting accuracy than manual planting and is preferred in the USA because of its efficiency and consistent production outcomes (Zhou et al., 2015). Tractor-attached potato planting machines in the USA range from 4 to 12 rows, with tractors requiring between 120 and 350 hp. Examples of these planting machines are listed in Table 6.

In contrast to the USA where planting operations are predominantly mechanized, potato planting in South Korea is generally manual. Although a semi-automatic planting machine for potatoes has been developed in South Korea, its application is restricted because of the significant human input required for operation, which outweighs labor savings and consequently reduces work efficiency. Currently, most potato farms in South Korea rely on manual planting using potato planting equipment (Fig. 4).

The semi-automatic planting machine for potatoes developed in South Korea operates similarly to the mechanized planting machines used in the USA and can perform ridge forming, planting, and vinyl mulching simultaneously. This process involves the use of a cultivation blade and disk for ridge forming, followed by the manual placement of cut seed potatoes into the planting cup. Once the seed potatoes are deposited onto the soil, the machine covers them with soil and applies vinyl mulch to complete the process. However, this machine requires perforated vinyl for planting, which leads to lower work efficiency compared to manual planting. The operating methods of the planting machines currently used in South Korea are the same, and some of the planting machines used are listed in Table 7.

Table 5 Introduction of vinyl mulching machines used in South Korea

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
AM-180R/ Asia technology/ Korea	Cultivator-attached	* 	-	1
BG-900B/ Bulls/ Korea	Tractor-attached	** 	Over 50	1

*Source: Asia Technology Home page, https://www.asiakor.com. **Source: Bulls Home page, http://www.ibulls.co.kr

Table 6 Introduction of the potato planting machines used in the USA

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
8060-6 Row Conventional Potato Planter/ Spudnik/ United States	Tractor-attached	* 	Over 180	6
Double L 9580/ Double L/ United States	Tractor-attached	** 	Over 200	8
8312-12 Row Folding Potato Planter/ Spudnik/ United States	Tractor-attached	*** 	Over 350	12

*Source: Spudnik Home page, https://www.spudnik.com. **Source: Double L Home page, https://www.doublelglobal.com. ***Source: Spudnik Home page, https://www.spudnik.com

Maintenance Process

During the maintenance stage, which includes weeding, pest control, and fertilization operations, the approach to potato cultivation in the USA differs from that used for larger-scale crops such as corn or wheat. Because potatoes

Fig. 4 Potato planting operation through human labor in South Korea

are grown on a smaller scale than these crops, drones are not used for maintenance tasks. Instead, tractor-attached and self-propelled sprayers are utilized, equipped with tanks that can hold up to approximately 6000 l or more. Recent advancements include the development of sprayers that incorporate digital technologies and artificial intelligence to enhance their efficiency and automation. For example, some machines feature technologies that automatically adjust the spray angle to ensure uniform application on uneven terrains. Additionally, vision processing systems that use machine learning to differentiate between potato stems and weeds have been developed, allowing for more precise control and fertilization (Terra et al., 2021). Examples of sprayer machines used in the USA are listed in Table 8.

In South Korea, pest control primarily relies on mechanical methods utilizing both tractor-attached and self-propelled sprayers, whereas a few small farms still perform control operations manually. Tractor-attached sprayers dispense liquid through a tank and a nozzle system mounted at the rear of the tractor. The sprayers were self-propelled and powered independently, allowing the operator to directly control the application. However, these methods often struggle with uniformity and precision, particularly in areas with rough terrains. To address these challenges, there has been a recent shift toward the use of drones for control work (You et al., 2021). However, its wide application cannot be achieved unless barriers such as high purchase and maintenance costs and limited battery life can be overcome. Examples of potato maintenance machines used in South Korea are presented in Table 9.

Harvesting Process

In the USA, the potato harvesting process is divided into two main stages: (1) the digging operation and (2) the collecting operation. During the digging operation, a machine known as a "windrower" simultaneously excavates 4 to 8 rows of potatoes. As the windrower passes, the harvested potatoes are deposited onto a discharge unit and aligned in rows. During collection, potatoes are further processed by a "potato harvester." This machine excavates aligned potatoes in rows in step 1; separates unwanted materials, such as soil, stones, and vines, from potatoes; and collects potatoes in a separate rock box. Potato-collection machines typically operate on 2–4 rows at the same time. The potatoes stored in the rock box are conveyed to a truck positioned alongside the collection machine to be transported to other facilities. This direct transfer to the truck helps minimize disease and spoilage by allowing potatoes to be promptly moved to storage. Harvesting machines used in the USA are listed in Table 10.

In South Korea, potato harvesting is typically performed using either cultivators or tractor-attached harvesting machines, depending on the size of the agricultural land. These machines excavate potatoes by rotating an excavator. There are two primary types of harvesting machines: excavation and excavation/collection. Excavation-type harvesting machines require manual collection of potatoes after they are uprooted. In contrast, excavation/collection-type machines can simultaneously transfer and collect potatoes in ton bags using a conveyor belt. However, because of the stony nature of Korean soil, these machines often encounter issues, such as collisions with potatoes, damage, and increased mechanical failure rates during operation. In addition, stones must be sorted manually during the transfer process. Excavation/collection machines also face challenges owing to their increased length, which results in a larger turning radius. This makes them less suitable for the narrow fields commonly found in South Korea. Consequently, although these machines offer efficient collection, their limitations in handling rocky soil and maneuverability in confined spaces affect their applicability in the South Korean agricultural environment (Lee et al., 2020). Examples of the harvesting machines used in South Korea are listed in Table 11.

Table 7 Introduction of the potato planting machines used in South Korea

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
KG-PH9000/ Kangnong/ Korea	Tractor-attached	* 	Over 60	1
RDK-PJ2/ Rodem korea/ Korea	Tractor-attached	** 	Over 45	2
DRP-2000RN/ Dooroo/ Korea	Tractor-attached	*** 	Over 85	2

*Source: Kangnong Home Page, https://www.knong.kr. **Source: Rodem Korea Home page, https://www.rodemkorea.kr. ***Source: Dooroo Home page, http://www.dooroo21.com

Discussions and Conclusions

In this study, we compared and analyzed the differences in potato production areas, cultivation methods, and use of agricultural machinery in the USA and South Korea. With large-scale agricultural land, potato cultivation in the USA often follows a double-row pattern, in which agricultural machinery is specifically designed for standardization.

Table 8 Introduction of the potato maintenance machines used in the USA

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
2510L Liquid Fertilizer Applicator/ John deere/ United States	Tractor-attached	 *	Over 180	-
Nitro 6300/ Miller/ United States	Self-propelled	 **	Over 300	-
STS16/ Hagie manufacturing/ United States	Self-propelled	 ***	Over 400	-

*Source: John Deere Home page, https://www.deere.com. **Source: Miller Home page, https://www.millerstn.com. ***Source: Hagie Manufacturing Home page, https://www.hagie.com/

This standardization supports efficient large-scale production and mechanization across various stages of cultivation. Conversely, potato cultivation in South Korea is restricted by its narrow agricultural land and mountainous terrain, leading to different cultivation patterns: Single-row cultivation is predominant in highland areas for summer potatoes and either single- or double-row methods for spring potatoes. The use of agricultural machinery in South Korea differs significantly from that of the USA. While the U.S. has achieved a mechanization rate of 100% with machinery capable of handling large-scale and diverse tasks simultaneously, South Korea faces challenges

Table 9 Introduction of the potato maintenance machines used in South Korea

DPM-180NS/ Daepoong/ Korea	Tractor-attached	* 	-	-
IS-1000/ Iris spreaders/ Korea	Tractor-attached	** 	-	-
BG-180/ Bulls/ Korea	Self-propelled	*** 	-	-
Remo-Farm 10/Uconsystem/ Korea	Agricultural drone	**** 	-	-

*Source: Daepoong Home Page, http://www.dpmc.co.kr. **Source: Iris Spreaders Home page, http://www.iksanfm.com. ***Source: Bulls Home page, http://www.ibulls.co.kr. ****Source: Uconsystem Home page, https://www.uconsystem.com

Table 10 Introduction of the potato harvesting machines in the USA

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
Double L 6560/ Double L/ United States	Tractor-attached Windrower	* 	Over 285	6
6180-8 Row Folding Potato Windrower/ Spundnik/ United States	Tractor-attached Windrower	** 	Over 300	8
6740-4 Row Potato Harvester/ Spundnik/ United States	Tractor-attached Potato harvester	*** 	Over 250	4
Double L 973/ Double L/ United States	Tractor-attached Potato harvester	**** 	Over 295	4

*Source: Double L Home page, https://www.doublelglobal.com. **Source: Spudnik Home page, https://www.spudnik.com. ***Source: Spudnik Home page, https://www.spudnik.com. ***Source: Double L Home page, https://www.doublelglobal.com

Table 11 Introduction of the potato harvesting machines in South Korea

Model/ Company/ Nation	Type	Structure	Horsepower requirement (hp)	Number of rows
DR-600/ Dooroo/ Korea	Cultivator -attached	* 	Over 8	1
GWN-1400/ Gangwon/ Korea	Tractor-attached	** 	Over 43	1
DR-1500CN/ Dooroo/ Korea	Tractor-attached	*** 	Over 60	2
SH-C1100/ Shinheung/ Korea	Tractor-attached	**** 	Over 55	1
HD-PC900/ Hyundae agricultural machinery/ Korea	Tractor-attached	***** 	Over 55	1

*Source: Dooroo Home page, http://dooroo21.com. **Source: Gangwon agricultural machinery Home page, http://www.xn--939a0mg9an0gt38a.kr. ***Source: Dooroo Home page, http://www.dooroo21.com. ****Source: Shinheung Home page, http://www.sh-ind.co.kr. *****Source: Hyundae agricultural machinery Home page, https://hd-agrimachine.com

owing to its small-scale farms and complex topography. Many farms still rely on labor and small tractor-attached machinery, and some operations are performed manually. These disparities are largely attributable to differences in agricultural infrastructure and economic factors. The U.S. promotes large-scale mechanization to enhance productivity, supported by extensive research and capital investment (Daum, 2023). In contrast, South Korea's agricultural landscape is constrained by a declining rural population, an aging workforce, and limited land area, making the introduction of large-scale machinery challenging (Song et al., 2022). To address these issues, it is essential to develop small-scale multipurpose agricultural machinery tailored to South Korea's narrow and varied terrain. Implementing modular mechanical systems that allow for interchangeable parts based on specific tasks can enhance operational efficiency. Through this system, various agricultural tasks can be performed using a single machine, thereby maximizing the utilization of machinery and reducing production costs and labor. Additionally, it is necessary to standardize cultivation patterns and the use of agricultural machinery to enhance the efficiency and productivity of potato farming in the primary potato production areas of South Korea. By integrating standardized cultivation methods and machinery operations with advanced agricultural technologies such as IoT, artificial intelligence, and drones, Korean potato farmers can achieve more systematic management. Future research should focus on the development of agricultural machinery tailored to the potato cultivation environment in South Korea, as well as detailed strategies for the mechanization and adoption of standardized agricultural technologies.

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Declarations

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