Harvesting Technology and the Transformation of Women's Roles in Rural Areas

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Abstract

The shift from traditional to modern harvesting methods has significantly impacted the labor structure of rural farmers. Traditional harvesting technologies, which actively engaged women, contrast with modern mechanized harvesting techniques that exclude women from harvesting activities. This study aims to analyze the development of harvesting technologies in Cikeusik Village and examine the effects of modernization on women's roles, social positions, and power relations within the agrarian structure of Cikeusik Village. A descriptive qualitative approach was employed, utilizing in-depth interviews, observations, and document analysis for data collection. The informants consisted of six female farmers, two combine harvester operators, and two community leaders, selected purposively using snowball sampling techniques. The findings reveal three distinct phases of harvesting technology in Cikeusik: traditional harvesting using ani-ani (pre-1970), the transition from ani-ani to sickles and threshing (1980–2017), and the use of combine harvesters (2017–present). The introduction of combine harvesters drastically reduced women's participation in harvesting activities, shifting a previously female-dominated labor force to a task performed exclusively by a few male operators. Consequently, women lost a source of seasonal income and transitioned primarily into entrepreneurship or conventional domestic roles.

***Keyword**: Harvesting Technology Modernization, Gender Roles in Agriculture, Combine Harvester Adoption, Women's Labor Participation, Rural Agrarian Transformation.*

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A. INTRODUCTION

The agricultural sector in Indonesia has undergone significant transformation over the past few decades, primarily through the adoption of mechanization technologies as a strategy to enhance productivity and efficiency (Haris et al., 2024). One prominent technological innovation widely implemented today is the combine harvester, a modern machine capable of performing cutting, threshing, and cleaning operations in a single process. The primary objectives of utilizing this technology are to reduce production costs, accelerate harvesting activities, and minimize post-harvest losses (Andriani et al., 2025). It is claimed that the use of combine harvesters can decrease harvest losses by 10–15% while significantly speeding up the harvesting process (Gummert et al., 2020).

This transformation has not only influenced technical and economic aspects but has also fundamentally altered the social structure and labor relations in rural communities. Prior to the introduction of combine harvesters, manual harvesting required the involvement of substantial labor, particularly women. Women played a vital role in various post-harvest activities, including cutting rice stalks with sickles, manually threshing grain, drying the harvest, and assisting in storage processes (Swastika, 2012).

Agricultural transformation through mechanization cannot merely be understood from a technocratic or economic-productivist perspective; rather, it must be analyzed within the broader dynamics of power relations and structural inequalities in rural societies. Agricultural modernization processes frequently generate new forms of inequality, including the marginalization of social groups that have historically held essential roles (Kinseng, 2024).

The introduction of combine harvesters has largely replaced manual harvesting work. Activities that previously engaged dozens of female laborers are now carried out by only two or three machine operators, who are typically men (Alam et al., 2018). This phenomenon has led to the exclusion of women farmers, particularly in terms of losing access to seasonal employment, sources of income, and social roles historically embedded in agricultural activities. Women are often positioned as "irrelevant" to machine-based technologies, as they are perceived to lack the physical strength and technical skills deemed necessary (Tahir et al., 2019).

Technology is never socially neutral; it carries embedded power relations, cultural values, and underlying gender structures (Satyavathi, 2011). In agricultural contexts, the introduction of heavy machinery such as combine harvesters often reinforces patriarchal structures because men have greater access to, and control over, technological resources. Women, who were previously active in agricultural production, experience displacement from core production processes and are compelled to seek new roles within modern agricultural systems (Tahir et al., 2019). This demonstrates that mechanization has implications not only for technical processes but also for social structures and gender relations within rural communities.

These changes align sociologically with Soemardjan's (1964) theory of social change, which posits that social change occurs when there is a shift in the structure of social institutions, including patterns of labor division and interpersonal relations within society. New technologies such as combine harvesters do not emerge in a social vacuum; rather, they are embedded within patriarchal structures where men have greater access to training, equipment distribution, and control over resources. In the context of mechanized harvesting, these dynamics have reshaped the division of labor between men and women, as well as the economic and symbolic roles they occupy in agrarian communities.

Everett Rogers' (2003) diffusion of innovations theory emphasizes that technology adoption is not a neutral process but a social phenomenon that carries consequences for values, normative systems, and power relations. Rogers argues that groups with limited access to information, training, and decision-making tend to become late adopters or are even left behind in the modernization process (Rogers, 2003). In this context, female farmers face both structural and cultural barriers that marginalize them within agricultural modernization processes.

Much of the literature on agricultural mechanization focuses predominantly on efficiency and productivity outcomes, with little attention given to relational and cultural dimensions, particularly from a gender perspective. The exclusion of female

farmers is rarely examined as a structural issue related to the equitable distribution of technology and access to production resources.

It is therefore essential to explore more deeply how agricultural modernization through the adoption of combine harvesters not only generates efficiency but also constructs new social hierarchies in rural areas. Against this backdrop, the objectives of this study are: (1) to analyze the development of harvesting technology in Cikeusik Village, Wanasalam District, Lebak Regency; and (2) to examine how the modernization of harvesting technologies affects changes in women's roles, social positions, and power relations within the agrarian structure of rural communities.

B. METHOD

This study employed a descriptive qualitative research approach, which primarily focuses on gaining an in-depth understanding of meanings, perspectives, and experiences of individuals or groups within specific social contexts (Creswell, 2014). The research was conducted in Cikeusik Village, Wanasalam District, Lebak Regency. The village was selected due to its characteristics as an agrarian area where the majority of residents work as rice farmers and have adopted the use of combine harvesters in their harvesting processes. Data collection was carried out over a three-month period, from August to October 2024.

The study utilized both primary and secondary data. Primary data were obtained through several techniques: first, in-depth interviews with six female farmers and two combine harvester operators. Informants were selected purposively and through a snowball sampling technique based on their involvement and knowledge of the harvesting process and related social dynamics. Data were also gathered through participant observation, which involved direct engagement in agricultural and harvesting activities to understand work patterns and gender involvement in the field.

Secondary data were collected from various written sources, including books, scientific journals, articles, and other relevant documents, such as village records and farmer group reports. Data analysis followed the framework developed by Miles, Huberman, and Saldaña (2014), which consists of four stages: data collection, data condensation, data display, and conclusion drawing (Miles, Huberman, & Saldaña, 2014).

C. RESULT AND DISCUSSION

1. Development of Rice Harvesting Technology in Cikeusik Village

The development of harvesting technology in Cikeusik Village, Wanasalam District, Lebak Regency, illustrates a gradual dynamic of change in line with the evolution of time and the increasing need for efficiency in the agricultural sector. This transformation can be broadly categorized into three main phases: the traditional phase (pre-1970), the transitional phase (1970–2017), and the modern phase (2017–present). Each phase has distinct characteristics regarding the tools used for harvesting and has generated different socio-economic implications for the

community, particularly concerning the roles and positions of women within the local agrarian structure.

The initial phase, prior to 1970, saw farmers in Cikeusik Village relying on a very simple traditional harvesting tool known as the ani-ani. The ani-ani is a small device consisting of a sharp metal blade attached to a short wooden handle. It was used manually by cutting rice stalks one by one. This process was extremely slow and required a large amount of labor, particularly women, who served as the primary workforce during the harvesting season.

Entering the 1970s, as the demand for efficiency and faster harvesting grew, farmers began to adopt more practical harvesting tools, namely the sickle (arit) for cutting rice stalks and the gebot as a threshing device. The sickle enabled faster cutting and allowed larger quantities of rice stalks to be harvested compared to the ani-ani, while the gebot was used for threshing by striking rice stalks against a wooden surface or board to separate the grain from the straw.

The technological transformation of harvesting in Cikeusik reached a modern phase in 2017 with the introduction of the combine harvester as the primary harvesting machine. The combine harvester is a multifunctional machine capable of performing three processes simultaneously: cutting, threshing, and separating rice from the straw. This technology significantly reduced the need for manual labor and accelerated harvesting operations on a large scale.

a. Traditional Harvesting Using the Ani-ani (Pre-1970)

Between 1850 and the 1970s, farmers in Cikeusik Village relied on local rice varieties known as pare gede or tall rice (padi jangkung). Within this traditional agricultural context, harvesting practices utilized tools and techniques passed down through generations, reflecting local technological adaptations to the geographical and sociocultural conditions of the community. The primary tool used in the harvesting process was the pisau etem, more commonly referred to as the ani-ani.

This tool represented a simple innovation of the traditional knife, equipped with a wooden handle that allowed farmers to manually cut rice stalks with greater ease. Despite its simplicity, it was effectively designed for use in both wetland rice fields (sawah) and dryland farming areas (huma). Due to its low operational speed, harvesting required a prolonged period, which created extensive opportunities for women to participate as harvest laborers, thereby making them an integral part of the local agricultural production system (Kurniawan, 2021). In other words, during this phase, women played a highly active and visible role in the agricultural cycle.

> "*In the old days, before 1970, we used the etem knife (ani-ani) for harvesting. One rice plot could be finished in a day if five people were working on it, and each person could harvest about ten bundles (ranggeong) per day*," (E, 55 years old).

The use of the etem knife or ani-ani in paddy fields allowed farmers to cut mature rice stalks with precision and efficiency, even in muddy field conditions. Meanwhile, in dryland or huma areas, which were relatively drier, the etem knife remained the primary harvesting tool. Differences in land conditions did not diminish the functionality of the etem knife as the primary harvesting implement. Farmers

employed similar techniques in both ecosystems, demonstrating the high flexibility of the etem knife in accommodating diverse agricultural environments. After cutting the rice stalks, the harvested crop was gathered and transported from the planting area, while the remaining stubble in the field needed to be cleared thoroughly in preparation for the next planting season.

> *"Whether in the paddy fields or in the dryland farms (huma), harvesting still used the ani-ani. The rice was cut directly from the stalk and then stored in the leuit (a traditional rice storage barn)," (A, 60 years old).*

In the post-harvest land-clearing stage, farmers in Cikeusik Village used another traditional tool known as the kujang. This tool, with its distinctive curved blade design, was effectively used to cut remaining rice stalks and remove other vegetation growing in the agricultural fields.

The land-clearing process was not only important for field cleanliness but also played a significant role in maintaining soil health. Plant residues left uncleared could serve as breeding grounds for pests and plant diseases, which could potentially disrupt subsequent planting seasons. Hence, this practice contributed to sustaining the agricultural cycle.

Traditional technologies such as the etem knife and kujang reflect farmers' deep understanding of the natural environment and agricultural cycles. The use of these tools demonstrates that the farming community in Cikeusik Village had developed an agricultural system rooted not only in technical efficiency but also imbued with cultural and ecological values.

Local knowledge accumulated over generations formed a traditional technological system that was adaptive, cost-effective, and community-based. However, one limitation of using the etem knife was its inefficiency in terms of time. In a single working day, a farmer could harvest only about ten ranggeong, each weighing approximately five kilograms. The wage system applied was also conventional, with one ranggeong granted as a day's wage for hired laborers.

> "*For the wages, one day of work equals one ranggeong, which weighs about 5 kilograms*," (A, 60 years old).

This condition demonstrates that, while traditional technology could meet the agricultural needs within the local context, it had limitations when confronted with large-scale production demands. Nevertheless, the persistence and utilization of these tools until the 1970s serve as evidence that traditional technology held its own resilience and relevance within the village farming system.

Figure 1. ***Ani-Ani***

b. Transition to Sickles and Threshing Boards (1970–2017)

The shift from local rice varieties such as pare gede or tall rice (padi jangkung) to high-yield rice varieties in Cikeusik Village brought significant changes to farmers' harvesting practices. The high-yield varieties adopted since the 1970s had different morphological characteristics, particularly shorter plant height compared to pare gede. These differences prompted a transformation in harvesting tools and techniques, moving away from reliance on the etem knife toward methods better suited to the needs of modern rice varieties.

This technological transition did not occur abruptly but rather unfolded through a process of knowledge exchange. Farmers from Java, who had already adopted more modern agricultural technologies, played a crucial role in introducing new harvesting methods to farmers in Cikeusik Village. Their presence in the surrounding areas of Wanasalam and Pandeglang significantly contributed to transferring more efficient harvesting skills adapted to the characteristics of high-yield rice.

> *"In the past, we used the tall rice variety, so we harvested with the ani-ani. Then, in the 1970s, we switched to high-yield varieties, and the Javanese people told us that for high-yield varieties, it's better to use sickles and threshing boards because the rice plants are shorter,"* (M, 70 years old).

Although the tools used during this phase were still manual, their efficiency was higher compared to the previous period. This change had a dual impact: on the one hand, it accelerated the harvesting process; on the other hand, it began to shift the labor structure that had previously been dominated by women. The use of sickles and threshing boards required greater physical strength, which led to an increase in male participation in harvesting activities.

Nevertheless, women continued to play an important role during this phase, particularly in post-harvest activities such as drying, collecting grain, and cleaning the harvested rice. Although their involvement was reduced compared to the ani-ani era, women still remained part of the agricultural production chain. This phase

represents an ambivalent condition: while efficiency improved, gender role equality began to experience a gradual shift.

One of the techniques introduced was cutting rice stalks closer to the base, allowing for a faster harvesting process without requiring specialized tools like the ani-ani. After the stalks were cut, the next step was to separate the grains from the stalks by striking them against a wooden surface known as a gebotan. Locally referred to as ngagebot, this process was carried out with the help of a sickle, a simpler and more practical cutting tool compared to the ani-ani. In practice, the rice stalks were struck against the gebotan surface with a base underneath to prevent the grains from scattering.

> *"Ngagebot is different from ani-ani. With ani-ani, we cut the rice from the stalks, but with ngagebot, we cut the rice from the whole plant and then strike it against a wooden board, with a mat placed underneath. Using the threshing board is fasterone plot can be finished in two hours with five people working on it,"* (M, 70 years old).

The ngagebot technique demonstrated a new level of efficiency in the threshing process, which previously required more time and physical effort. The shift from the etem knife to the sickle, and from the ngetem technique to ngagebot, marked an adaptation to the new agronomic realities brought about by the adoption of high-yield rice varieties. Beyond increasing harvesting speed, this method also simplified post-harvest processing, particularly in separating grains from their stalks. Although these tools remained simple, their effectiveness continued to hold relevance within the traditional farming system that still relied heavily on manual labor.

Despite these improvements, limitations were still evident, especially in terms of time and labor efficiency. One plot of rice fields could typically be completed within two hours by four farmers, each paid IDR 40,000 per day. Compared to ani-ani, which required five workers and one full day for a similar plot, the ngagebot method offered a clear efficiency gain. However, this approach still faced challenges when applied to larger-scale agriculture and higher productivity demands.

Figure 2. Gebotan

c. Adoption of Combine Harvesters (2017–Present)

Alongside the increasing demand for food and the growing need for labor efficiency, more modern agricultural innovations were introduced. One of the most significant innovations was the combine harvester, commonly referred to as the "combine." This machine integrates three main functions into a single processcutting, threshing, and cleaning harvested crops. The combine harvester enables harvesting to be completed in significantly less time and with far fewer laborers.

The combine harvester was first introduced in Cikeusik Village in 2017. It quickly drew the attention of farmers in Cijaha Block, who requested that their fields be harvested using this machine. Since then, the use of combines has expanded widely. The key advantage of this machine lies in its efficiency: one plot of rice fields can be harvested in just 20 minutes with only two workers, namely the driver and an assistant. This means that a single combine harvester can replace the work of four farmers using sickles and threshing boards, or five farmers using the traditional ani-ani method.

> *"In 2017, the combine harvester was first introduced in Galonggong Block. Using the combine is much fasterif we have one plot of rice fields, it can be completed in about 20 minutes, and the fee is IDR 600 per kilogram,"* (A, 56 years old).

Although the combine harvester brought substantial benefits in terms of labor and time efficiency, it also presented new challenges. One of the primary obstacles is the high cost of purchasing the machine, which can reach tens to hundreds of millions of rupiah. Consequently, not all farmersespecially small- and medium-scale farmerscan afford to own one, prompting many to opt for machine rental instead. However, renting a combine harvester is not without its issues, including high rental costs and the limited availability of machines, particularly during peak harvest seasons when demand surges simultaneously. Rental fees are typically calculated based on the weight of the harvested grain, averaging around IDR 600 per kilogram.

The transition in harvesting technology in Cikeusik Villagefrom etem knives to sickles and threshing boards, and eventually to combine harvestersreflects a gradual process of transformation within the local agricultural system. This adaptation has been shaped by changes in crop varieties, evolving labor needs, and the community's openness to external agricultural innovations. Although not without limitations, this transformation has paved the way for greater efficiency and improved productivity in the village's agricultural sector.

> *"In the past, we used to rotate labor (liliuran, or mutual cooperation), so during harvest, we helped each other. But when the combine came, that tradition became rare because everyone now uses the combine, so we have to pay for it instead,"* (A, 56 years old).

The shift from traditional harvesting tools such as sickles and threshing boards to modern harvesting machines (combine harvesters) in Cikeusik Village has brought changes not only in the technical aspects of agriculture but also in the social and cultural structures of farming communities. Previously, harvesting activities in the village were highly collective and embedded with the values of gotong royong

(mutual cooperation). Farmers typically worked together, assisting each other in harvesting rice, creating strong social interaction and cohesion among community members. However, with the advent of combine harvesters, this tradition of collective harvesting has begun to fade. Mechanized and faster harvesting processes have shifted what was once a communal activity into a more individualized practice.

The use of combine harvesters has had a direct impact on the position of farm laborers within the agricultural production system. The speed and capacity of the machine to complete harvesting in a short time have rendered manual labor largely unnecessary. As a result, many farm laborers lost their jobs, particularly women who previously played a vital role in harvesting activities. This finding is consistent with Januarti et al. (2018), who noted that such changes create a concerning situation of marginalization, in which vulnerable groups dependent on seasonal agricultural employment are forced out of rice production processes in rural areas.

> *"Many are unemployed now, especially the women. Women used to join in during harvest, either ngetem or ngagebot, working as laborers to earn extra income. Now, there's no work left for us,"* (S, 63 years old).

Prior to the introduction of mechanized harvesting, tools such as the ani-ani and gebotan enabled the participation of a large workforce. As noted by Ulfa et al. (2024), women were not only involved in cutting rice stalks but also actively engaged in collecting and processing harvested rice. However, following the transition to combine harvesters, women's participation in harvesting activities has declined dramatically. The machine requires skilled operators, typically men, who are trained and experienced in its technical operation.

As a result, women who once actively contributed to harvesting have lost their roles, leaving behind disparities not only in terms of economic opportunity but also in social relations and gender dynamics. With their labor no longer needed in the harvesting process, women have lost opportunities to earn supplemental income from the agricultural sector.

Figure 3. Combine Machine

2. Transformation of Women Farmers' Roles

The mechanization of harvesting in Cikeusik Village, marked by the introduction of combine harvesters, has affected not only the technical aspects of agriculture but also brought profound social changes to the village labor structure. Women farmers, who previously played crucial roles in various stages of agricultural production, have experienced significant social and economic role shifts. This aligns with Akter's (2017) argument that, in traditional farming systems, women farmers were actively engaged in almost all agricultural stages, particularly during the harvest season.

They worked as rice cutters, carriers, threshers, and grain dryers. As agricultural laborers, women earned seasonal wages that, although modest, were vital in supporting daily household needs, financing children's education, and supplementing family income. With the introduction of combine harvesters during the third phase of harvesting technology development in Cikeusik Village (post-2017), a significant transformation occurred in the division of labor within the agricultural sector. The harvesting machine, capable of replacing human labor in cutting, threshing, and cleaning rice grains, drastically reduced the need for manual laborparticularly female labor. This automation created efficiency in the production process but simultaneously led to the gradual yet systematic displacement of women from agricultural work. As work opportunities for women in the harvesting sector diminished, their economic contribution to household income contracted.

> *"In the past, women were heavily involved in agricultural activities, especially during harvest. Women did ngetem and ngagebot, while men cut the rice. So, women often worked as laborers, earning IDR 45,000 per day to help supplement the family's income,"* (E, 64 years old).

The impact of this transformation has been profound. Women who once earned daily wages from harvesting activities have now lost a key source of income. As the agricultural sector no longer offers sufficient space for female participation, many women have experienced a social role repositioning, becoming full-time housewives. This not only increased women's economic dependence on their husbands but also shifted gender role dynamics within families and the broader community.

However, the disappearance of roles in agriculture does not mean that rural women have become entirely passive. Faced with economic pressures due to job loss, many women have demonstrated economic resilience by transitioning into informal sector work. This transformation highlights that agricultural technology is never socially neutral. While harvest modernization has increased production efficiency, it has also created structural impacts on labor relations and gender roles. In the case of Cikeusik Village, women have experienced marginalization in the primary production sector but, on the other hand, have begun to find new roles in the informal economy and household food production.

Therefore, it is essential for agricultural development and technology policies to consider social and gender aspects in their implementation. An approach that

focuses solely on efficiency without accounting for social equity risks creating inequality and the exclusion of certain groups, in this case, rural women. Consequently, the transformation of women's roles amid harvest modernization must be understood as part of broader social dynamics that require policy interventions grounded in equity and empowerment.

The introduction of combine harvesters has gradually eliminated many traditional roles previously held by women. Machine operators are typically men, while women are neither given opportunities to operate nor to engage in machine maintenance. Moreover, there are no training schemes designed specifically for female agricultural laborers. Even in decision-making processes regarding when and how these machines are used, women are excluded.

As a result, women farmers have been quietly displaced from the agricultural production system. They are no longer called upon to work during harvest, and their seasonal income sources have disappeared. With agricultural work inaccessible, women have begun seeking income from other sectors, such as selling food or small garden produce in local markets, working as casual laborers, or, in some cases, migrating to urban areas or seeking employment abroad in the informal sector.

> *"Now we can no longer work as harvest laborers because everything is done with the combine. So, women have turned to selling fried snacks, planting vegetables like chili, tomatoes, and water spinach in their yards to reduce household expenses, or simply becoming full-time housewives,"* (E, 64 years old).

This transition has not been easy. Not all women possess the social capital, skills, or networks needed to enter new sectors. As a result, many rural women experience hidden unemploymentremaining outside productive labor while still trapped in cycles of household poverty. This transformation reflects a shift in social structures, consistent with Soemardjan's (1964) assertion that when work systems or social institutions changein this case through technological advancementthe social functions of individuals within society also inevitably change (Soemardjan, 1964).

Women who previously held productive functions and public roles in agriculture have now been reduced to domestic roles that are neither socially nor economically recognized. In the past, women were present in the rice fields as part of a productive agrarian society. Today, they are considered "unnecessary" in harvesting because machines are deemed more efficient. This represents a form of social delegitimization of women's roles, where their presence and contributions to agriculture are perceived as irrelevant within a labor system increasingly dominated by machines and technology.

This transformation has affected not only women's economic roles but also their social identities. For many rural women, working as farm laborers was not merely a source of income but also part of their agrarian identity. When excluded from agricultural workspaces, they also lost a sense of pride and social existence within their communities. Another consequence is the emergence of new inequalities between men and women (Akter et al., 2017). Men now hold control over technology, farmer group networks, and market relations, while women are increasingly

marginalized from decision-making processes and the distribution of economic benefits.

The socio-economic transformation caused by the introduction of combine harvesters demonstrates that agricultural modernization has not been gender-inclusive. Women farmers face structural impoverishment, losing access to employment, income, and social recognition. This supports Soemardjan's theory that changes in social institutions, such as work systems, inevitably alter the social roles and functions of rural citizensin this case, women. Without gender-sensitive interventions, technologies that are meant to advance agricultural productivity risk widening social gaps and reinforcing patriarchal structures in rural areas.

The adoption of the combine harvester as a modern harvesting technology in Cikeusik Village has indeed delivered efficiency in terms of time and labor but has also exposed significant gender-based disparities in access to, and control over, technological innovations. Modern technology in this context is predominantly controlled by men, whether as machine owners, operators, or key decision-makers regarding its use.

Access to work tools in traditional agricultural systems has often been determined by land ownership. When the combine harvester was introduced as a strategic harvesting tool, its distribution and management were controlled by farmers with greater financial capacity. This resulted in womenparticularly farm laborers and smallholder farmersnot only being displaced from harvesting work but also denied opportunities to access or learn how to operate the machine (Elizabet et al., 2016).

Within the framework of Everett M. Rogers' (2003) Diffusion of Innovations theory, technology adoption is a social process influenced by communication networks, social trust, and perceptions of innovation. Rogers categorizes adopters into five groups: innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003).

Male entrepreneurs and landowners typically occupy the position of early adopters or early majority because they have initial access to combine harvesters, training information, and connections with agricultural extension agents and government programs. In contrast, female farm laborers often fall into the late majority or even laggard categories because they lack direct access to information, have limited opportunities for training, and are deemed irrelevant in the process of technological distribution. This highlights that inequality in access to innovation is not a technical issue but rather the product of a social structure that systematically discriminates on the basis of gender.

Gender inequality in technology access creates a vicious cycle of marginalization: women are not trained, are perceived as incapable, are excluded, and thus become even less likely to access technology. When only men control technology, women's productive value and bargaining power within the social and economic system of the village further decline (Boserup, 1984). Over the long term, this reinforces a patriarchal agricultural structure in which access to resources, decision-making authority, and control over the means of production are concentrated in the

hands of men. Yet women remain an essential component of the agricultural system and village livelihoods.

The situation in Cikeusik Village demonstrates that the introduction of the combine harvester has created structural inequality in technology access, with men as the dominant actors and women as marginalized groups. This inequality is not caused solely by the technology itself but by how it is introduced and managed within a patriarchal social structure. Rogers' (2003) Diffusion of Innovations theory helps us understand that unequal adoption is inherently social rather than individual. Cultural constructs and patriarchal values are the primary barriers to women's participation. Without gender-equitable interventions, agricultural modernization risks reinforcing male dominance and perpetuating an agricultural system that is structurally and socially unjust.

Modernization programs, such as ownership of combine harvesters and the selection of machine operators, are conducted within spaces predominantly controlled by men. Women, especially those working as agricultural laborers, have never been primary subjects of modernization policies and are often not regarded as important actors within contemporary agricultural systems. This is evident from the absence of gender-based training programs that would provide women with opportunities to learn about agricultural technologies.

> *"During harvest now, women don't really do anything, unlike before when we could work in shifts or as laborers. Now, at most, we just dry the harvested rice,"* (L, 58 years old).

Women have not only lost seasonal employment during harvest but also lost control over critical resources such as equipment, income, and access to land. In the past, women still held a social position as needed harvest laborers, but in the current mechanized farming system, their roles are considered irrelevant. The inequality at play is not merely economic; it is also rooted in broader power relations. Development and technology cannot be separated from gender relations because development processes frequently take on a masculine form, engaging primarily male actors in their design, distribution, and utilization (Johnson et al., 2016).

While technologies such as the combine harvester improve efficiency, when access is concentrated in the hands of one social groupin this case, menmodernization becomes a tool for reproducing inequality. In this context, the combine harvester is not merely a harvesting tool but also a symbol of socio-economic power that reinforces the dominance of one gender over the other. In other words, instead of serving as a tool for empowerment, the technology has restricted women's participation and reinforced their subordinate position within the village farming system.

The marginalization of women farmers should not be viewed merely as a technical consequence of mechanization but as a symptom of structural injustice in the distribution of access to technology and production resources. The loss of employment and income not only worsens the economic conditions of smallholder farming households but also deepens social inequality (Mehta et al., 2018). When agricultural laborers are displaced and women lose spaces to contribute to

agricultural production, the social structure of the farming community experiences significant disruption.

Rural women experience a dual impact from this modernization process: loss of access to employment, as mechanization replaces manual labor positions previously filled by women; loss of social bargaining power, as they are excluded from decision-making structures; and exclusion from access to training, capital, and technology, leaving them unable to overcome their structural disadvantages. This situation creates a pattern of structural marginalization, in which women are perceived as incapable, excluded from participation, denied access, and increasingly considered irrelevant.

D. CONCLUSION

The development of harvesting technology in Cikeusik Village has undergone three main phases: the traditional phase (ani-ani), the transitional phase (sickle and gebotan), and the modern phase (combine harvester). During both the traditional and transitional phases, women played a crucial role throughout the harvesting process, from cutting and threshing to drying the harvested rice. The introduction of the combine harvester in 2017 brought about a drastic change in agricultural labor patterns.

The combine harvester successfully improved harvesting efficiency and reduced the need for manual labor, but it also created exclusionary effects for women. Roles that had previously been performed by women were replaced by machines operated by men. Women were denied access to training, information, and control over the equipment, resulting in the loss of seasonal employment, income, and social standing within the farming community.

This technological transformation has directly impacted the labor structure and power relations in rural areas. Women, who had once been an integral part of the agricultural production processparticularly in harvestinghave been marginalized, forcing them to shift their roles toward small-scale entrepreneurship or full-time domestic responsibilities.

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