AN EXPLORATION OF THE GENDERED EFFECTS OF MECHANICAL MUNGBEAN HARVESTING IN PAKISTAN

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KEYWORDS

Mechanization, Machinery, Social Impact, Technology Adoption, Qualitative Research

ABSTRACT

Agricultural mechanization is important to increase farm incomes through greater farm labour productivity, but could also have adverse social consequences, for instance, by marginalizing the role of women in agriculture. The study aims to gain better indulgent of how mechanization of the smallholder farming affects the role of and benefits for women from agricultural work using case of mungbean in Pakistan. Mungbean is an important summer pulse in Pakistan, but average yield is very low at about 1 t/ha. Mungbean production is partially mechanized in all parts of the country, but harvesting and weeding are done using manual labour, most of it provided by women. Primary data come from interviews with 106 persons in two villages; one in which mechanical harvesting had been adopted and one comparable village where it had not been introduced. The data collection methods were mostly qualitative. The results indicate that men and women perceived mechanization of mungbean harvesting largely as positive as it reduces the burden of work on women and reduces health risk from the field work.

INTRODUCTION

In Pakistan, the agriculture contributes to 18.5 percent of annual GDP (GOP, 2018). The area under pulses is around 1.17 million hectares, 96 percent of which is planted to four major pulses: chickpea, lentils, mungbean (also called green gram) and urd bean (also called mash bean or black gram). The country's total pulses production was 0.6 million tons in 2018 (GOP, 2018). Mungbean is a major summer field crop, but the average yield is only about 1 tonnes/ha, which is low compared to other countries. Main limitations are unavailability of good seed, crop pests and diseases, uncertain weathers conditions, and labour **s**hortage (Rani, Schreinemachers & Kuziyev, 2018). Despite these limitations, the fact is that mungbean is the only crop in which the country is self-sufficient. Pulses are harvested by hand, which is time-consuming and expensive when having to hire labour. Generally, the cost of harvesting can approach 50 percent of the marketable crop value in developing countries (Summerfield, 1988).

Pakistan Agricultural Research Council and Arid Zone Research Institute in association with the World Vegetable Center introduced mechanization of harvesting and threshing in Pakistan under United States Agency for International Development (USAID)-funded agricultural innovation program. Mechanization was first introduced to farm households in selected villages of Bhakkar District in Thal Region of Punjab Province. This study's objective was to gain better indulgent of how mechanization of smallholder mungbean farms would affect women's role in mungbean production and the benefits they derive from it. The study hypothesized that the mechanization of the harvesting could increase productivity and improve incomes. It could also lead to more land being brought under cultivation to meet increasing market demand for mungbean (Diao, Cossar, Houssou & Kolavalli, 2014). Foremost, it could potentially reduce human drudgery in agricultural production. The study identified constraints and opportunities for farmers to participate and benefit from mechanized mungbean production.

LITERATURE REVIEW

Agricultural mechanization generally refers to the application of tools, implements, and powered machinery as inputs in agricultural production (Clark & Clark, 1997). According to FAO (2013), the three power sources used in the agriculture are human power, animal power and motorized power. The adoption of the non-human power sources to carry out agricultural work is major driver of agricultural growth. Sustainable mechanization, as defined by FAO (2017), is the introduction of proper machinery to farmers to ensure that their agricultural production is environmentally sustainable and farming methods are efficient. It potentially raises the income of farmers and conserves natural resources by intensifying sustainable crop production practices, which may create a virtuous cycle of better productivity, improved incomes and improved livelihoods. According to Pingali (2007), mechanization of energy-intensive agricultural operations like land preparation, threshing, grinding and milling is characterized by motorized power and animal traction replacing human labour.

However, labour-intensive operations such as planting, weeding, and harvesting require human judgment and mental input in addition to energy. Summerfield (1988) described that pulses are successfully and systematically harvested mechanically in the developed countries. Still, traditional methods of cultivation are more commonly used in lower-income countries because farmers have small land holdings, availability of machinery is low, and pulses are typically grown on marginal lands. In addition, crop residues may have a secondary usage in some regions and this may impede mechanization if machines collect or chop the residues. Several studies have been conducted on the impact of the agricultural mechanization on production, productivity, cropping intensity, employment and the income generation. Various studies have concluded that the farm mechanization enhances the crop production and productivity due to increased timeliness of operations, better quality of the operations and output and the greater precision in the application of inputs (Verma, 2005; Singh, 2001).

Past studies have also shown higher grain losses in manual threshing as compared to using combine harvesters, with variations among crops and cropping systems (Hassena, Ensermu, Mwangi & Verkuijl, 2000; Pingali, Bigot & Binswanger, 1987). Sisei (2016) indicated that a shift to mechanization in mungbean operations leads to changes in the yields, labour savings, a reduction in the burden on family labour, area expansion (in terms of greater cropping intensity), and an improvement in the quality of marketed output. FAO (2017) also indicate that it is clear from an examination of gender related impacts of technological change in agriculture that one needs to bear in mind that intra-household allocations of labour, income and access to land as factors coercing women or affecting their ability to benefit from change. Labour-intensive manual work in pulses production in Pakistan is usually carried out by farmers and families with limiting factor in production of pulses (Sisei, 2016).

Pakistani women usually play a key role in mungbean weeding, harvesting, threshing, and winnowing. These activities involve low physical energy but are a form of drudgery as the work is dull, repetitive, and fatiguing. Rani et al. (2018) estimated that one hectare of mungbean requires about 129 hours of labour time and that harvesting, threshing and winnowing accounted for about 60 percent of this time and women are much involved in this process. The women perform these tasks in addition to other household functions such as housekeeping, meal preparation, child and elderly care, livestock management, and the collection of firewood. Women therefore work for much longer hours than men. The mechanization of pulses production could therefore benefit women in particular (Yadav, Sujik, Narendra & Hardev, 2019) as it could free up some of their time in the routine life and for their household work, leisure, personal care or other productive work (Pingali, Bigot & Binswanger, 1987).

MATERIAL AND METHODS

The qualitative methods used to collect primary data were selected from a range of tools developed by the international food policy research institute as part of the gender, assets and agriculture project (Dick, Rubin, Mulema & Myers, 2019; Malapit, Quisumbing, Dick, Seymour, Martinez, Heckert, Rubin, Vaz, Yount, 2019). The tools are listed in Table 1. First, we constructed village profiles by interviewing key informants including a village representative, a teacher and a local health worker. The purpose was to gain a general understanding of the context of village regarding the cropping pattern, source of income, demographic information, infrastructure, financial services, level of education, and availability of health facility for men and women and children by using structured list of the open-ended questions.

The second tool was general focus group discussions (FGDs) with groups of male and female respondents. The discussions focused on the gender empowerment, role in the agriculture and decision making at household and farm level. The third tools were FGDs with groups of men and the women focused on mungbean production in the village. This provided data on mungbean specific issues. Through these interviews we identified who usually perform activities in mungbean production, benefits this provides, disadvantages and constraints. The fourth tool was the construction of seasonal crop calendar in a group discussion with women, which helped to better understand variation in women's workload throughout the season.

Table 1 Data Collection Tools used and Number of Respondents

SN	Tool	Type of respondents	Respondents/ Village	Total 2 Villages
1	Community/village (informant interviews)	3 interviews with the key informants: village representative, teacher and health worker for two villages	3 key informants	6
2	Focus group discussion-general topics	1 group of the male and 1 group of female participants from two villages	8-10 men 8-10 women	40
3	Focus group discussion-Mungbean specific topic	1 group of male/female participants partaken in Mungbean cultivation in two villages	10-12 men 8-10 women	40
4	Focus group discussion-seasonal calendar	1 group of male/female participants and draw seasonal calendar for whole year in two villages	4-5 men 4-5 women	20
	Total respondents			106

Data were collected from two villages selected from Bhakkar District, which is the largest mungbean growing area in Pakistan, supplying 70 percent of country's total mungbean output (GOP, 2015). The mechanization of harvesting and threshing has been introduced in a few selected villages in this district by Agricultural Innovation Program (AIP). The project modified available wheat combine harvesters for use in the mungbean harvesting and trained combine operators in their use. The project trained farmers in agricultural practices necessary for mechanical harvesting such as line sowing and use of desiccants to stimulate crop ripening to enable machine harvesting. The study was therefore able to do an in-depth comparison among villages with and without mungbean mechanization.

The study first selected the village with mechanization, which was Chak-53 TDA in Tehsil Bhakkar. The AIP had introduced mechanized weeding, harvesting and threshing to this village. We purposively selected Chak-75 ML in Tehsil Mankera as a comparison village as it had very similar characteristics as Chak-53 TDA in terms of the climatic condition, the mungbean production, cropping patterns, infrastructure and communication, but mungbean production especially weeding and harvesting was done using manual labour.

The data were analysed using charts and notes from the field, and means were calculated from the quantitative data.

RESULTS AND DISCUSSION

Socio-Economic Characteristics and Land Use

Table 2 shows the socioeconomic profile of the respondents in the two study villages. The village without mechanized mungbean harvesting has a larger population, but about 90 percent of households in both villages were involved in the agricultural production. The average land holding was 4.5 acres in the village with mechanization and 5 acres in the village without mechanization. The major source of drinking water were boreholes with pump while irrigation was supplied by tube wells and canals.

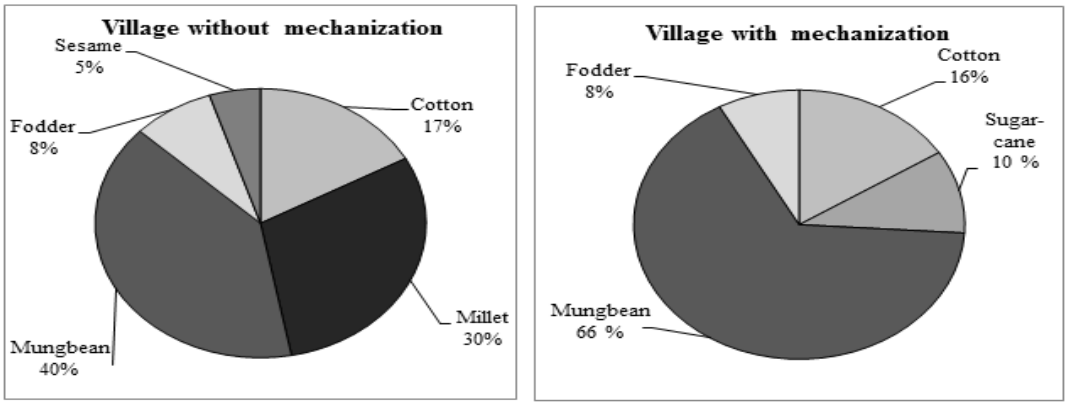
Table 2 Socio-Economic Characteristics of Two Selected Villages

Characteristics	Chak-53 TDA (with mechanization)	Chak-75 ML (without mechanization)
Households	230	400
Total population (persons)	1,800	3,000
Female population (%)	50	55
Households doing farming (%)	90	88
Land holding (acres)	4.5	5.0
Most important pulse crop	Mungbean	Mungbean
Source of drinking water	Borehole with pump	Borehole with pump
Source of irrigation water	Canal 50%/Groundwater 50%	Canal 40%/Groundwater 60%
Soil type	Sandy loam	Sandy

Mungbean was the most important crop by area during the summer (*kharif*) season in both villages. Mungbean was sown in June-July and harvested in August-September. Figure 1 compares the cropping patterns during the *kharif* between two villages. Wheat was the major winter (*rabi*) crop in both villages. In village with mechanization, wheat was grown on 85 percent of crop area during the *rabi* season while in the other village it was 60 percent. Chickpea is also a *rabi* pulse in the village without mechanization and cultivated on 20 percent of the land followed by citrus orchards.

In the village with mechanization, farmers indicated that the area under mungbean has expanded relative to cotton and sugarcane. However, in village without mechanization, farmers indicated that the mungbean area, although it is high, has gradually reduced. The reasons they gave for this decline included the uncertain weather conditions, the unavailability of labour, and pests and diseases. Farmers shifted land to orchards, millets and fodder crops.

Figure 1 Cropping Patterns During the Summer (*kharif*) Season in Two Study Villages

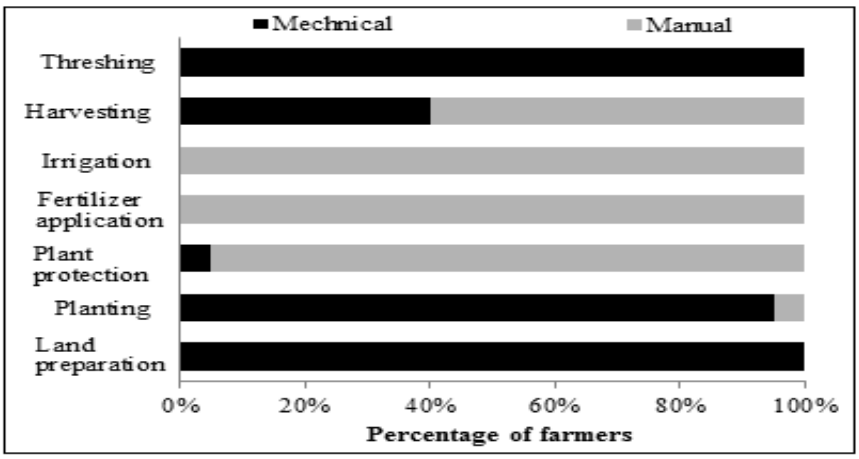


Mungbean Production

Various operations in mungbean production are either done manually or mechanically using animal traction or machines. Figures 2 and 3 show the extent of mechanization of mungbean production in both villages. It shows that in the village with mechanization, about 40 percent of the farmers used machinery for mungbean harvesting and threshing by using a wheat combine harvester. The wheat combine harvester was also available in the other village but there it was only used for wheat, not for mungbean and they did not know how to use it for mungbean harvesting. The results indicate that in the village with mechanization, 95 percent of the farmers sowed their crop by machine in rows.

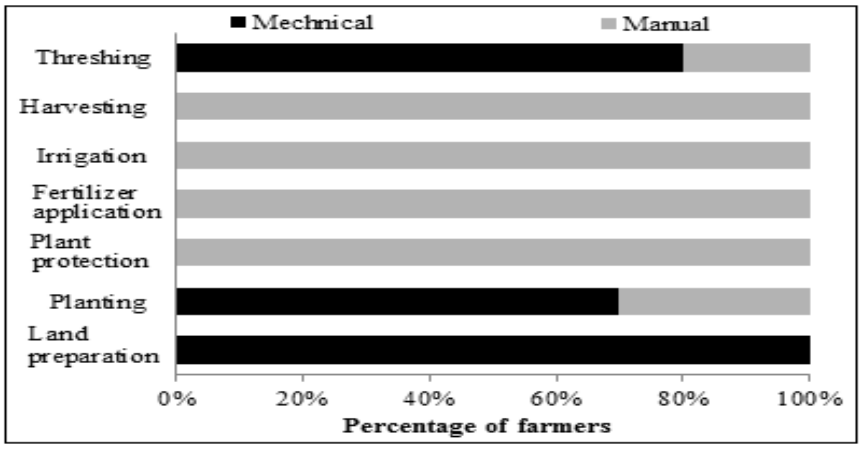
In the other village, farmers mostly sowed mungbean by manually broadcasting. Sowing is done by male family labour and hired male labour in both villages. Insects and pests were the major issues affecting mungbean yields in both the villages. In the mechanized village, farmers manually sprayed post-emergence insecticides and herbicides (Lactofen, Haloxyfop-R-Methy l) and controlled weeds by hand-picking in the field. The manual weeding was mostly performed by family members and hired labour, including women and children. The farmers who had large land holding mostly hired labour for weeding and some of them used a machine, called a 'boom sprayer' to control weeds.

Figure 2 Mungbean Cultivation Practices in Village with Mechanization



The respondents explained that shortage of labour was the most serious challenge to agricultural production and especially in pulses. In both villages labour was not easily available in peak season for harvesting and weeding. The shortage of labour increased the cost of production as wage rates hiked during the harvesting season.

Figure 3 Mungbean Cultivation Practices in Village Without Mechanization



Regarding threshing, two methods were commonly used in the study villages: first, the manual harvesting in combination with using a mechanized wheat thresher; second, a combine harvester for harvesting and threshing together. In village with mechanization, farmers used both methods while in other they were only aware of and applied the first method. Respondents mentioned that combine harvester is a very effective harvesting method, but a major issue is need for uniform maturity of the crop. Haddad, Salkini, Jagatheeswaran and Snobar (1988) and Gaur, Jukanti, Srinivasan & Gowda (2012) also mentioned that the indeterminate growth habit and sequential ripening of pulse pods is one of reasons to pick manually. Therefore, there is a need for varieties that are suitable for machine harvesting by having synchronized maturity and suitable plant architecture. Another constraint to mechanical harvesting identified by respondents in village with the mechanization was weed called the *cucumismelo* var. *Agrestis*, locally called the *Chibber*. Farmers mostly sold the mungbean to *beapori* (middleman) at the farmgate in both the villages.

Role of Gender in Mungbean Production

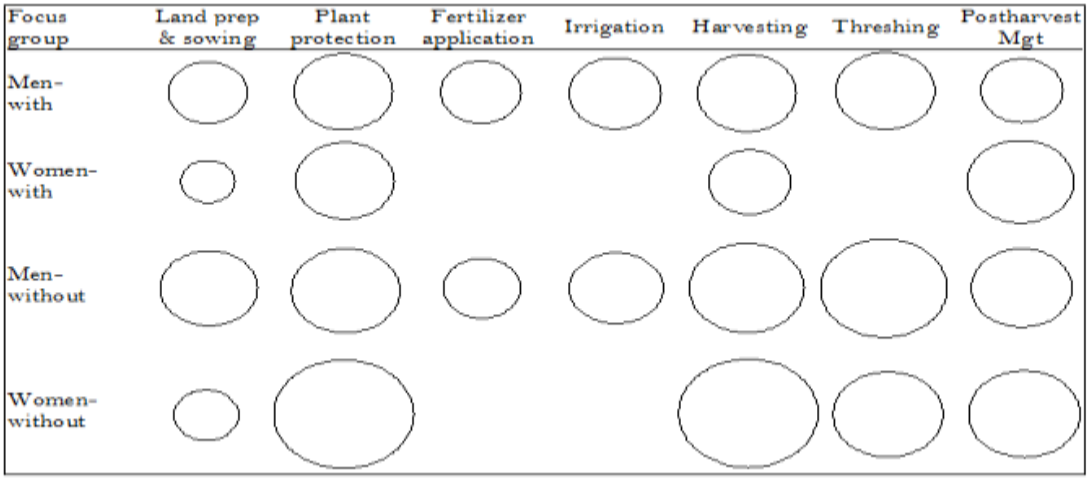
Mungbean seasonal calendars were constructed to gain an in-depth understanding of the workload for men and women and to identify difference between the villages with and without mechanization (Table 2). During the interviews, men and women were asked to pictorially present their workload at subsequent stages of mungbean production. This was done using a large sheet of paper posted on a wall with participants asked to draw circles representing their relative workload. The table shows that the larger circle for a relatively heavy workload and the smaller circle for a lighter workload. Women in both villages were involved in the sowing, weeding, harvesting, threshing and the postharvest management in the mungbean in their respective villages. Only, the few women were involved in manual drill sowing by helping men at the field.

In the village with mechanization, most farmers applied post-emergence insecticides and herbicides on the mungbean using knapsack sprayers (manual spray machine). After application of pre-emergence herbicides, the farm family also picked weeds from the field to make their field weeds free. This task was mainly performed by women, but also involved men and children. In village with mechanization, farmers used both methods while in other they were only aware of and applied the first method. However, in village were mungbean harvesting is partially mechanized, the crop was harvested manually as well as by machine. The farmers used combine harvester which are locally available for wheat harvesting. After the crop was fully mature, the combine harvesters were used to cut and thresh the crop. In village without mechanization, the whole family was involved in mungbean harvesting but women did most of the work.

In both discussions (with men and with women), the farmers identified that the manual harvesting involved drudgery by picking the pods at several times during the summer season. In the village with the mechanization, men and women had a lower workload in mungbean production as compared to the other village. However, in both villages whole farm families contributed to farm work. To assess comparative workload of women over the year, a seasonal workload analysis was carried out in both the villages among women involved in agricultural activities along with other tasks (Table 3). Number of asterisks represents amount of agricultural work/month. It shows that during whole year women are busy in household chores along with livestock management agricultural task (in seed storage, harvesting, threshing and weeding of different crops.

Notes: with and without referring to the villages with and without mechanized mungbean harvesting. The size of the circles depicts the workload during mungbean production of man and women. (with) and (without.) indicate beneficiary village and non-beneficiary village, respectively. Seasonal workload analysis of women.

Table 2 Gender Workload in Mungbean Production in Selected Villages



In both villages only few women were engaged in off-farm work such as teaching. The farm families, and especially women, were involved in cleaning of fields and grading of seeds, harvesting of wheat and sugarcane, picking, hoeing and cotton weeding, weeding and harvesting of mungbean, harvesting of mustard, handling crops at household level and livestock rearing. Women were also involved in kitchen gardening. Harvesting and threshing of mustard were done by men and women. Livestock activities such as fodder cutting, feeding, watering, cleaning of shades and milking of the animals were performed by women. It therefore shows that women are busy during the whole year. During the *rabi* season (from December to March) in village with mechanization, farm women were busiest with households, livestock and farm-related work including harvesting sugarcane and Mustard crop. From October to November, cotton was picked and these were the busiest months for women because they worked the whole day in the field. In the months from March to April harvested and threshed mustard and stored wheat for household consumption and seed. June was the least busy month for farm women.

Table 3 Women Farmers' Monthly Workloads

Season	Month	With mechanization	Without mechanization
Rabi (Winter)	October	****	****
	November	***	***
	December	****	**
	January	****	***
	February	****	***
	March	***	***
	April	***	***
Kharif (Summer)	May	***	***
	June	**	***
	July	**	***
	August	***	****
	September	***	****

Note: Number of Asterisks Indicates the Workload.

During the *kharif* season farmers grow cotton and mungbean. Women were busy with mungbean weeding and harvesting. In the village without mechanization farmers grew rapeseed and they involved in manual harvesting and threshing. August and September were busiest period for women due to weeding and harvesting mungbean and weeding and hoeing of cotton. Male household members are generally considered as carrying the responsibility to handle various crops and as decision-maker at the farm, while female

household members and hired labour are considered as helping hands. Yet, contribution of women and hired labour is very high, especially during harvesting, weeding and post-harvest. Farmers hired labour and paid them wages, but the work of the women in the family goes unpaid because they believe that they are working for the family income.

Women in the household also have an important role in the post-harvest management including sun-drying, winnowing and storing of beans for home consumption and seed. Therefore, better crop management and the introduction of the machinery in mungbean (and sugarcane) will reduce workload for farm women as well as for men, and increase farm profits and improve the livelihood of community. Harvesting and threshing of mustard were done by the men and women. Along with this, hard farm work does not enhance women's ability and potential to produce food, earn income, ensure household maintenance, and care for family members. Therefore, the capacity enhancement would help women to add value to the farm produce through the post-harvest management.

Potential Benefits of Mungbean Mechanization

Through focus group discussions, respondents identified potential benefits of mungbean mechanization, especially in the harvesting and threshing. Farmers who had previous experience in applying the combine harvester and thresher thought that mechanization helped to increase the efficiency of the farm labour and reduce drudgery by reducing the total workload for men and women. Additionally, they perceived that it helps in reducing post-harvest losses and increasing the quantity of production. These benefits and savings in inputs help reduce production costs and allow farmers to earn a better income. In both villages, farmers perceived that if mungbean was fully mechanized then it would become an easy crop to produce and they would allocate the larger area to it. The erratic rainfall was identified as a major issue during mungbean harvesting in both villages.

In village without mechanization farmers reported that mungbean area was decreasing due to the bad weather conditions at peak harvesting time. The crop was damaged due to rainfall and wind. Farmers in other village faced the same challenge, but they were able to harvest and thresh crop on time and therefore had not so much losses. This was thus vital reason for farmers to prefer mechanical over manual harvesting. Labour scarcity was identified as another major constraint to mungbean production as it is traditionally a labour-intensive crop, especially for weeding and harvesting. Farmers in both villages indicated that during the harvesting period there was a shortage of labour which created difficulties for them and family. Wages for hired labour increased due to labour shortage and this affected their profits from mungbean. The farmers were unable to find enough labour during peak harvest time. Mechanization helped them to solve this problem.

Constraint to Mungbean Mechanization

In the village with mechanization, farmers who applied the combine harvester indicated that they faced problems with broken grains due to mechanical harvesting. Also, the crop residue was not saved when using the combine harvester. These residues are important for livestock feeding or for selling to local industry (used as fuel) and earn money by the farm family. Farmers also faced problems with shedding of grains when using a combine harvester. As combine harvesting for pulses is at an early stage of adoption, farmers had limited knowledge regarding the proper calibration and adjustment of the machine. Although combine harvester was considered as a very effective harvesting method, the lack of uniform pod maturity was still an issue. Farmers also reported problems with *cucumismelo* var. *Agrestis* locally called *Chibber*, which is related to high moisture in the grains. A range of other issues are also linked with the mungbean mechanization such as lodging of plants, unavailability of machines, lack of trained services providers, and unsuitability of machines for mungbean intercropping**.**

CONCLUSION

The study aims to gain better indulgent of how mechanization of the smallholder farming affects the role of and benefits for women from agricultural work using case of mungbean in Pakistan. Mechanization of mungbean production reduces labour costs and reduces the likelihood of weather damage by reducing the harvesting period. These benefits help farmers to earn a better income from mungbean and will thereby contribute to sustaining mungbean production. The result of this study showed that the introduction of machinery to assist in weeding and harvesting reduces women's drudgery in mungbean work, which already is one of the busiest periods of the year. There may be adverse effects on hired farm labour who are currently benefitting from high wages during the harvest season. Mechanical harvesting of mungbean is at an early stage in Pakistan. There is a need for farmers to have better guidelines, awareness and receive training through farmer field days and demonstrations.

Acknowledgement

This work was supported by federal ministry for economic cooperation and development (Germany) under the project "Beans with benefits: Integrating improved mungbean as a catch crop into dryland systems of Pakistan and Uzbekistan for increased smallholder farmer income and more sustainable production systems" and by long-term strategic donors to the World Vegetable Center: Republic of China (Taiwan), UK aid from the UK government, United States Agency for International Development (USAID), Australian Centre for International Agricultural Research, Germany, Thailand, Philippines, Korea, and Japan. We also acknowledge the support of Arid Zone Research Institute, Bhakkar, Pulses Program, Social Science Research Institute, NARC and Agricultural Innovation Program.

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