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Use of ASMC seeder prototype by women: Assessing the use of donkey (*Equus asinus*) as animal power source in agricultural mechanization in Hauts-Bassins region of Burkina Faso

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Abstract— *The present study aimed to evaluate the technical and socio-economic impact of using donkeys (Equus asinus) in agricultural production to facilitate the adaptation of the "ASMC" seeder for smallholder women farmers in western Burkina Faso. A survey consisting of eighteen (18) representative farms in ten (10) villages located in two (2) provinces formed the basis for semi-structured interviews with groups of women registered with the Regional Union of Cereal Producers. Descriptive statistics and correlation analysis were used to evaluate the survey data. Based on the survey results, the representative farms were primarily family farms with two methods of seeding maize: manual sowing and partial or exclusive use of the ASMC mechanical seeder. The draft donkey ownership rate was 68% on the manual and 41% on the mixed-method of seeding farms. Donkeys provided a significant reduction in the time needed for tillage and planting operations for 74% of the respondents, thereby improving the timeliness of farming activities. There was a positive correlation between total land use for farm activities and the number of draft donkeys on the farm. 67% of the women farmers believed that sowing with a pair of oxen was faster ($P<0.05$) than with one donkey power, as they usually do. The cost of sowing with the oxen was slightly higher compared to the donkey, but the cost of adoption was significantly greater for oxen ($P<0,05$). Based on this study, donkeys in these farming systems can increase productivity and improve women farmers' welfare.*

Keywords— ***agricultural mechanization, animal traction, ASMC-Seeder, donkey, women.***

I. INTRODUCTION

Burkina Faso is a landlocked country in West Africa with one long dry season (8 months) against one short rainy season (4 months). The country's economy is based mainly on agricultural pursuits, which employs nearly 85% of the working population, with an agricultural (GDP) growth rate estimated at about 9% against 4.35% for sub-Saharan Africa [1], Agricultural products are produced primarily on family farms that remain poorly mechanized despite many attempts to mechanize agricultural production in the country's western regions before and after independence, similar to many developing countries [2, 3]. Timely crop establishment is challenging due to unpredictable rainfall and poor soil. The current preference of producers is for

early sowing of crops to capture early season rains, but early planting is challenging to achieve with labor-intensive manual cultivation.

Sowing crops is mainly women's activity in western Burkina. It is still manual work requiring a large workforce, often resulting in low plant densities and crop yields due to inconsistent planting depth and spacing [4]. A mechanical seeder would speed up the planting process. Mechanization refers to tractors and combine harvesters and the small and medium-sized agricultural implements used in producing, processing, and transporting agricultural products [5] . Mechanical seeders have been introduced on farms in the past, but farmer training and on-farm demonstration work were insufficient to support widespread adoption.

In 2016, the Appropriate Scale Mechanization Consortium (ASMC) project, part of the feed the future lab and funded by USAID (United States Agency for International Development) was launched to improve agricultural mechanization in Burkina Faso. At that time, Stakeholders identified the need for appropriate and cost-effective animal traction tools suitable for both men and women. Tillage and planting equipment were identified as high priorities for development. The ASMC team worked side-by-side with local farmers and artisans to evaluate, build, and repair a conservation maize seeder using locally available materials.

The seeder features included specialized seed plates, furrow openers, furrow closers, and press wheels for minimally tilled, residue-covered soil. It was initially tested with oxen at the power source [6]. Compared to hand planting, the seeds were placed at a uniform depth and constant spacing; seeds germinated faster and emerged at a consistent rate. Because women were not confident handling oxen, the ASMC team aimed to evaluate the suitability of donkeys as a source of draft power for women.

Donkeys have played an essential role in agricultural activities in smallholder farms [7, 8]. Among other advantages of the donkey, women are generally more comfortable handling donkeys since they often use them for other tasks such as household and farm transport, riding, or trading [9, 10]. In recent years, considerable efforts have been made to scale up the use of draft donkeys in Burkina Faso. From 2018 to 2021, [11] reported that four training teams of five members each taught draft donkey usage to about 11000 farmers in the Imasgo, Tiogo, Sabouna, and Koalma regions in Burkina Faso.

The ASMC seeder was tested in 2017 with convincing results on the farms of five (5) producers in the Hauts-Bassins region [6]. Between 2018 and 2020, several ASMC seeders were given to cereal producers using oxen in cotton production areas to promote maize production in the region. The objective of this study was to evaluate the perception of the technical and socio-economic impact of the use of donkeys (*Equus asinus*) with the ASMC seeder among farmers who used this device to promote donkey-drawn seeders in the cropping system to improve planting timeliness and safety, and to ease the burden of smallholder women farmers Burkina Faso.

II. MATERIALS AND METHODS

2.1 Study site

The Hauts Bassins region in western Burkina Faso covers a total area of 25,479 km², or 9.4% of the national territory [12]. This region was one of the country's first agricultural production areas, mainly cotton and cereals. Its geographical location makes it an essential hub for domestic trade in agricultural products to neighboring Mali, Ghana, and Cote d'Ivoire. The region has a Sudanese-type climate characterized by the alternation of a dry season with a more marked rainy season than most of the country. The average rainfall level in the Hauts Bassin region is 1,043 mm in the south and 960 mm in the north. The study included eighteen farms representing ten (10) villages over 2 provinces (Tuy and Houet provinces) in the Hauts-Bassins region. The boundaries of the study area were based on the geographical distribution of the current users of the ASMC seeder. The areas visited were located using GPS and placed on base maps using the BNDT database [13] (Fig. 1)

2.2 The surveys and semi-structured interviews

The surveys included nine (9) farms using the ASMC seeder in each of the two provinces, totaling eighteen (18) farms among the ten (10) villages for the study (5 villages per province). Twenty-seven (27) people were surveyed in each province, totaling 54 respondents. The interviews took place in the localities of Lena and Bouéré, as well as at the FEPA-B headquarters of the regional farmers' union. Fifty-two (52) women participated, and 31% used the seeder (Fig. 2) on their farms. The questionnaire addressed the socio-economic characteristics of the producer as well as the perception of women about the seeder used with oxen or donkeys, as shown below:

Sowing time was the perception of the total duration of the time taken to complete the sowing per hectare.

Uniformity of sowing was measured as the spacing uniformity between crop rows, depth of seed placement, and plant spacing uniformity.

Ease of driving refers to perceiving the ease of hitching, animal handling, managing, and operating the seeder.

Operational cost compares manual (by-hand) seeding and mechanical seeding (ASMC seeder), based on cost per hectare. This includes the daily salary per woman for

sowing activities and food expenses for the duration of the work. The cost of sowing with the seeder includes the driver's payment per day.

The cost of adoption was assessed as the purchase price/depreciation of the seeder and the animals (oxen or donkeys), the annual maintenance costs (theoretically estimated at 10-15% of the purchase price), and the average annual costs for the maintenance of draft animals (feed and health care).

2.3 Description of the seeder

The mechanized maize sowing system is the current innovation, replacing the manual one. It consists of a seeder, draught animals, two operators (male/female that can be improved to one if draft animals are well trained) and the seed, on prepared soil. The system innovation involves the design of a multi-purpose single-row seeder with single seeding hole, which operates in rows and is designed to be easy to handle, practical and suitable for small-scale farmers. It can be designed entirely by artisans using local materials. This system compensates the manpower shortage in a context where it takes five adults three days to sow a hectare of maize, compared with 04 to 06 hours with the seeder. It is also suitable for sowing sorghum, millet and cowpeas (beans) using a plate (Fig. 2).

2.4 Data collection and analysis

The evaluation criteria were qualitative and based on the opinions expressed by the women survey respondents. For each question, the most frequent response was selected as the most representative of the opinion of the producers.

Data were analyzed using MINITAB (MINITAB Statistical Software, 22.1.0.0, 2024 Minitab.LLC), for basic descriptive statistics, 2-t-test and pearson's correlation. Observation frequencies and Chi-Square analysis were done using Epi Info (Epi InfoTM 7.2.4.0; CDC, Atlanta, GA, USA).

III. RESULTS AND DISCUSSION

3.1 Structural characteristics of smallholder farms and use of the ASMC seeder

Descriptive data on farm characteristics (TABLE 1) revealed that smallholder farms were mainly family farms with a hectare-to-worker ratio of 12:6 in small and medium-sized farms and 28:13 for large farms. Grouping by this method for seed sowing provided two (2) main types of farms: type 1 using manual sowing exclusively, and type 2 using mixed (by-hand and seeder) or exclusive use of the seeder for sowing. The representative cropland (ha) or the harvested agricultural area revealed by the survey were 7.3 ± 3.8 and 18.5 ± 13.1 ha, respectively, for the by-hand-only and mixed seeding farms. Land use for all farm activities (functional agricultural area) ranged from 11 ± 5.02 ha (by hand) to 26.9 ± 19.1 ha (mixed). Two (2) or three (3) pairs of draft animals (oxen or donkey) (9.5±9.1 animals) were typical for type 2 (mixed/mechanical) farms compared to one (1) pair (2.5±1.7 animals) on type 1 (manual) farms ($P<0.05$). Draft donkey ownership rates were 68% for by-hand seeding farms and 41% for mixed seeding farms. Sowing with the ASMC seeder represented about 11 % of the total land use for farm activities (functional area) (TABLE 1), with a strong positive correlation between total land use for farm activities and number of draft donkeys on the farm ($P<0,05$) (TABLE 2). There was a positive correlation between cropping areas or the harvested agricultural areas and the areas sown with the seeder ($P<0.05$) (Fig. 3). A positive correlation was also seen between the areas sown with the seeder and the number of draft oxens (Fig. 4), while the corresponding correlation was negative for the number of draft donkeys (Fig. 5).

All the women questioned were married, and their average age was estimated to 41.7±5.25 years. They owned draft animals with a percentage of 75% of donkeys and 25% of oxen. The women also owned private lands, with a mean area of 0.5±0.35 ha, while the mean land area of the households was estimated to be 10.7±6.89 ha. 75% of the women using the ASMC seeder used it in their private land only, while 25% used it on both private land and the household one. Women used the seeder for sowing mainly maize, and barely rice or groundnut.

In general, awareness of and availability of suitable agricultural machines and other forms of mechanization are low in Burkina Faso. At the outset of the ASMC seeder (seeder) project in 2016, an advisory group of stakeholders, including farmers, technical service providers, educators, farmer union representatives, and others, projected that the process of training and adoption of new cropping system technologies would take five years on average; time for seeder development and testing, two successful crop campaigns and time for education and training. Developing a reliable seeder at a reasonable cost and level of complexity, including field testing and training local artisans to build the Seeder, required two cropping seasons. At the farm and village level, Seeder adoption included on-farm testing and evaluation, financial support, workshops in machine/tillage/seeder use, adjustment and function of components, and development of on-farm demonstration/training sites with the backing of influential, leading farmers.

Currently, there is a low level of use of the ASMC seeder in crop-livestock farms in the Hauts-Bassins region because the seeder was only recently introduced. Only 11% of the total cultivated areas, one seeder / 43, 5 ha was sown with

the ASMC seeder between 2017 to 2019. This rate is low compared to [14], who reported a use ratio of one seeder / 6.5 ha in the Groundnut Basin of Senegal, where the local seeder was well established. However, the positive correlation seen between the harvested areas and the areas sown with the seeder in the present study is an indicator of the contribution of the seeder in increasing crop production in smallholder farms. Furthermore, the negative correlation seen between the areas sown with the seeder and the number of draft donkey in this study confirms that most of the farmers in type 2 farms did the sowing using draft oxens instead of draft donkey, and this was confirmed by the positive correlation seen with the number of draft oxens. Nevertheless, this survey aimed to understand women's perception of the ASMC seeder to guide further seeder design and training efforts. Few active demonstration sites as well as extension and educational programs had been developed. Extension and training strategies were based on the findings of the project. They prioritize the needs of low-income, smallholder women farmers, who were a key target group for seeder development. Women feared working with oxen, and they lacked access to them early in the planting season because they were in poor physical condition, and men typically had priority access [9,10]. Therefore, there is a need to develop seeders suitable for donkeys drawn and the full range of agricultural activities.

3.2 Social impacts of the presence of donkeys on the farm

Monitoring agricultural calendar: for 74% of the respondents, using oxen for plowing and transporting inputs or equipment is difficult because of their poor physical condition due to scarce feed supplies at the start of the growing season. The use of donkeys reduces the preparatory work before the planting activities begin which improves the timeliness of planting throughout the agricultural calendar.

Fodder collection and storage for animal nutrition: 100% of farms owning donkeys also use them for domestic transport (water, construction aggregates, general goods, etc.). These extra-agricultural services are provided in the form of rental but also by mutual aid between families within the village. In addition, the capacity of the farms with donkeys to collect and store crop residues was greater than that of farms without donkeys since it was possible to make at least 2 trips/day for transporting and storing fodder for animal feeding during the dry season.

The survey results highlight the advantage of donkeys in the early rainy season, which leads to the timely completion of fieldwork, as well as the poor condition of oxen during the same period [15]. This is a natural zootechnical characteristic of donkeys, allowing them to be used more efficiently in farming than oxen (hardiness, endurance, maintenance cost) [16]. The social impact of the donkey on the farm results from the facilitation of domestic transport, an essential activity in the life of families in rural areas (water, construction materials, travel, goods, etc.) [7,8]. The use of donkeys as draft power along with oxen draft to advance the mechanization of small and low-income family farms should be supported. From a gender perspective, the survey results confirmed that women found the seeder easier to handle and cheaper with donkeys than oxens.

3.3 Women's perception of the ox-drawn versus donkey-drawn seeder

Women's perception of the seeder used with a pair of oxen compared to one donkey (as it was usually done in farming activities) is shown in TABLE 3. Sixty-seven percent (67%) of the respondents reported that the sowing time with oxen was faster compared to donkey power ($P<0.05$), with better animal tendency to stay on the row ($P > 0.05$). The uniformity of row width and plant spacing was perceived to be unchanged. For 51% of the observations, handling and operating the tool with a donkey was very easy compared to oxen, but not statistically significant. The cost of sowing with oxen traction was slightly higher compared to the donkey for 51%, while the cost of adoption was very high with oxen compared to the donkey for 78% of the observations ($P<0,05$).

The survey revealed that for most women, sowing with donkey traction was slower than bovine traction (5-6 h / ha with bovine traction compared to 8-10 h / ha with donkey traction). The travel speed of the oxen is faster than that of the donkey team. However, the difference in travel speed does not have a significant impact on the sowing schedule. Early prototypes of the ASMC seeder were tested with ox power, so it may be possible to modify the seeder for efficient donkey use.

The donkey's ability to pull agricultural equipment is more limited due to its low weight [16]. Donkeys are increasingly used for working with plows, seeders, and small plows in light soils, and many development projects use these possibilities [17, 11]. The ASMC seeder's average draft or pulling force was about 22-kilogram force (kgf), while donkeys typically weigh between 100 to 140 kg and can pull about 16-20% of their body weight [18, 19]. [20] in 1997 reported a draft capability of 12-25% of liveweight in donkeys. The ASMC seeder draft is within the capability of a draft donkey. The evaluation of the two power units (oxen and donkey) concluded that other performance parameters were similar, apart from the slightly shorter sowing time with bovine traction. Donkeys can be harnessed in pairs or larger teams for heavy work [17]. For example, up to eight donkeys in Botswana were used to pull a large plow [21].

Based on the survey, using the ASMC seeder with donkey traction may be the best way for women to sow. Moreover, farm mechanization policies and programs targeting female household members can reduce the gender-adoption gap, ultimately enhancing farm yield and profitability [22].

The cost of using the mechanical seeder with bovine traction is higher than that of donkey traction. This is based on the fact that the cost of use among producers is judged more on the profit made than the actual cost. In any case, the cost per hectare for mechanized sowing remains much lower than that for manual sowing, regardless of the type of traction used.

Regarding the cost of adoption, women unanimously concluded that adoption would be higher with bovine traction than with donkey traction. This calculation includes the cost of acquiring draft oxen and the annual maintenance costs (food, health, etc.), which were significantly higher than for donkeys. In Cameroon, donkey traction was shown to be more economical to purchase and maneuverable in cramped and stony plots than bovine traction **[23]**.

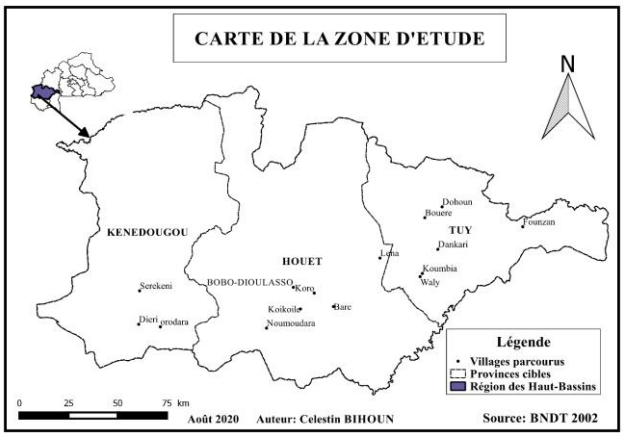

Fig.1: Map of the study site

Fig.2: The ASMC seeder (Barro et al., 2022).

Table 1: Characteristics of farms in the Haut-Bassin region according to the method used for sowing

Variable	Sowing type	N	Mean	SE Mean	StDev	Minimum	Median	Maximum	P-value

Family Size	Manual	27	11.1	0.84	4.40	6	11	29	0.035
	Mixed	27	17.4	2.3	14.4	0	15	54	
Number of active workers	Manual	27	6	0.3	1.6	3	6	11	0.021
	Mixed	27	9.1	1.3	6.6	0	8	26	
Functional agricultural area.	Manual	27	11	0.9	5.02	5	11	25	0.00
	Mixed	27	26.9	3.6	19.1	0	21	70	
Harvested agricultural area	Manual	27	7.3	0.7	3.8	3	6	17	0.00
	Mixed	27	18.5	2.5	13.1	0	14	52	
Number of draft animals	Manual	27	2.5	0.3	1.7	0	2	7	0.00
	Mixed	27	9.5	1.7	9.1	0	6	31	
Area sown with the seeder (%)	Manual		0						
	Mixed		11						
Possession of draft donkey (%)	Manual		68						
	Mixed		41						

Table 2: Correlation between draught donkey numbers and land use by farmers using the ASMC seeder in the Hauts-Bassin region from 2017 to 2019 (N = 54)

Parameter	**Drought donkey number**		**Comments**
	Significance (bilateral)	**Pearson's Correlation**	
Land use for maize cultivation	0.615	0.070	weak positive correlation
Land use with the seeder	0.888	- 0.020	Weak negative correlation
Functional area	0.000	0.575**	strong positive correlation

**. Significant positive correlation at 1% level.

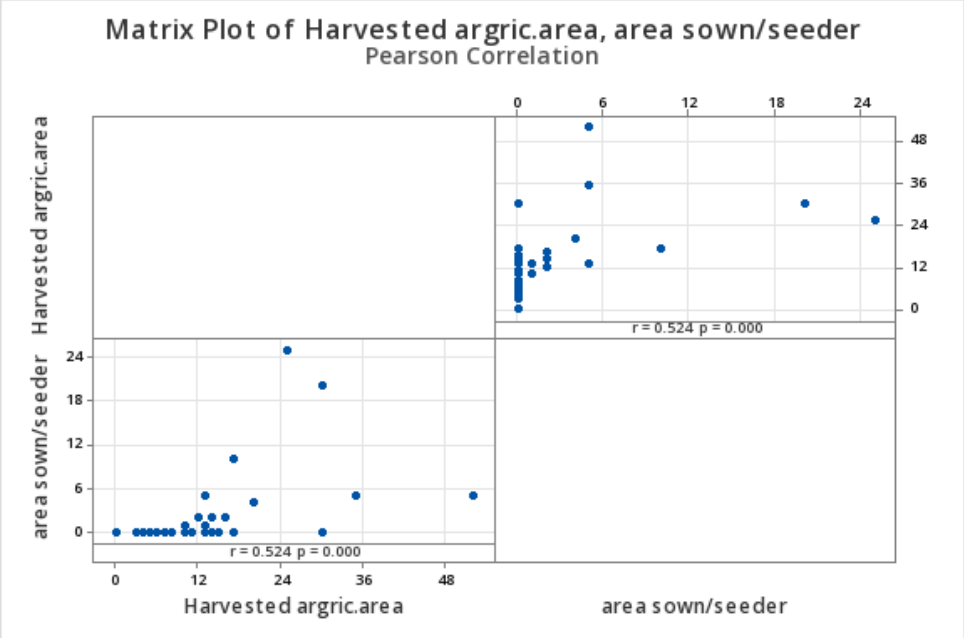

Fig.3: Correlation between harvested agricultural areas and areas sown with the seeder

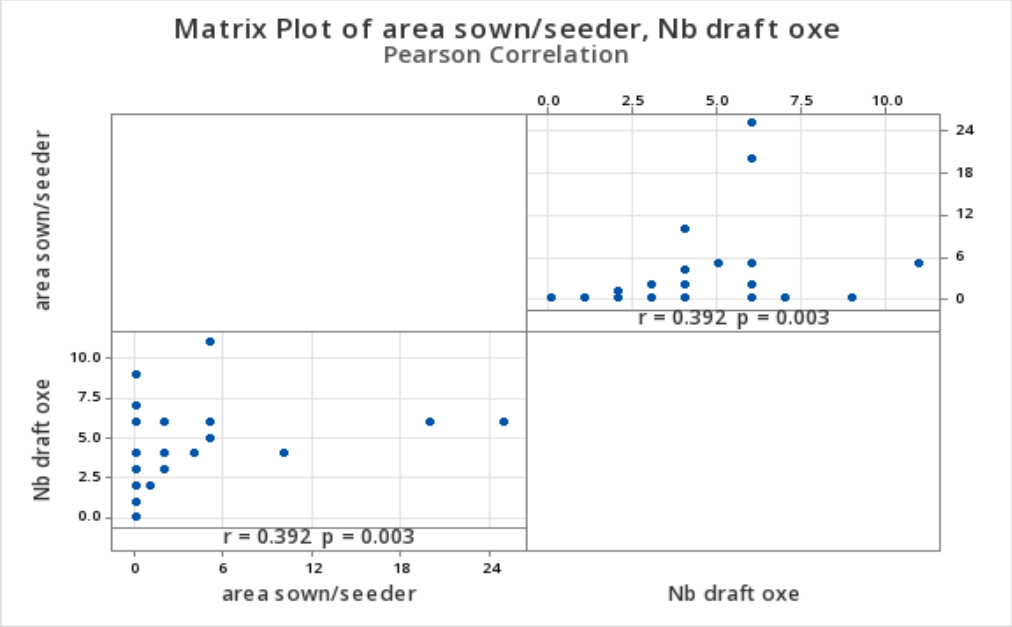

Fig.4:Correlation between areas sown with the seeder and the number of draft oxen

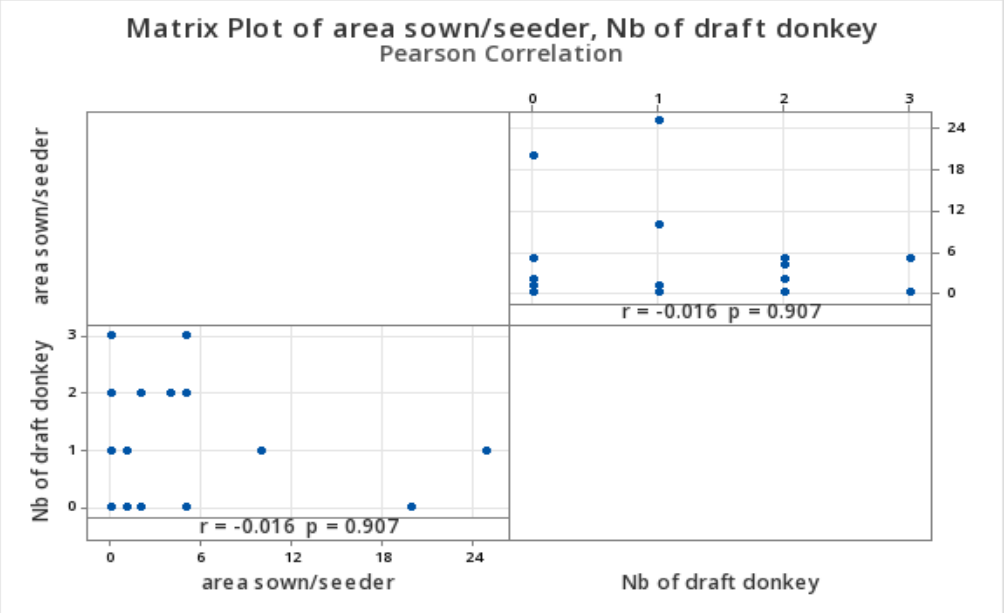

Fig.5:Correlation between the area sown with the seeder and the number of draft donkeys.

Table 3: Women's perception of the use of the seeder with oxen versus donkeys (%, N = 52)

Parameters	**Oxen**	**Donkey**	**P-value**
Sowing time			
Very short	67**a**	2**b**	P = 0.001
Short	31	33	P = 1.000
High	2**b**	65**a**	P = 0.002
Handling and operating the seeder			
Very easy	20	51	P = 0.667
Easy	29	25	P = 1.000
Less easy	51	24	P = 0.231
Animal tendency to stay on the row			
Good	67**a**	15**b**	P = 0.001
Not good	29	25	P = 1.000
Bad	4**b**	60**a**	P = 0.010
Draft power			
Very High	61**a**	14**b**	P = 0.000
High	25	25	P = 1.000
Low	14**b**	61**a**	P = 0.000
Regularity of sowing			
More regular	26	23	P = 1.000
Similar	52	50	P = 1.000
Less regular	22	27	P = 1.000
Cost of use			
Very High	51	33	P = 0.961
High	6	6	P = 1.000
Less high	43	61	P = 0.998
Cost of adoption			

Very High	78**a**	3**b**	P = 0.001
High	3	15	P = 0.964
Less high	19**b**	82**a**	P = 0.019

In the same row, values with different letters are significantly different at 5% level

IV. CONCLUSION

Adopting the ASMC seedeer with donkey (Equus Asinus) traction by women and small family farms with limited income can significantly reduce the drudgery of smallholder women farmers when seeding maize and other row crops while increasing grain yields. Introducing donkeys with the ASMC seeder system can improve the farm's work efficiency and socio-economic performance. Low-income women farmers successfully used the equipment with donkeys. The results of this study are guiding efforts to scale up the seeder distribution to farmers in Burkina Faso and throughout the region. A key aspect of scaling up the seeder is strengthening artisans' and blacksmiths' technical and operational capacities to improve and adapt the local repair, maintenance, and manufacturing capacity of the ASMC seeder suitable for donkey traction.

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