

LOCALLY ADAPTED MACHINERY SOLUTIONS FOR SUSTAINABLE INTENSIFICATION OF CROP-LIVESTOCK SYSTEMS IN TUNISIA

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ABSTRACT

Small crop-livestock systems in Low- and Middle-Income Countries (LMIC) such as North African ones are characterized by low mechanization levels, thus undermining their productivity and sustainability. Machinery being promoted in local markets are made and imported mostly from industrial Countries where farm systems are larger in terms of size. Prices of these machines are unaffordable for small to medium sized land-holding farmers who remain incapable of upgrading and modernizing their farming operations. Through its work on crop livestock integration under conservation agriculture (CLCA) and the CRP livestock (feed and forage flagship), ICARDA and its national partners in Tunisia have been working on developing small machineries well adapted to small farming systems, and contributing to crops rotations through inclusion of forage crops, enhance the quality of animal feed, and allow to reduce the impact of livestock grazing on soil covers. These machines include “small mobile seed cleaning and treatment unit” and “small mobile feed-grinder machine”, etc. and were all locally manufactured at low cost. Adapted business models have been developed to further deploy these machines to small and medium farmers’ cooperatives and other potential machinery service delivery enterprises, thus contributing to diversify and enhance their respective incomes.

INTRODUCTION

The conventional national seed system in Tunisia is not providing enough quality forage seeds. Forage seed production like barley, faba beans, vetch or alfalfa is mainly undertaken by large seed producing cooperatives through subcontracting with individual farmers. One private seed enterprise COTUGRAIN and the national Office of Livestock & Pasture OEP are equally engaged in forage seed production.

Due to insufficient forage seed supply, but also to save costs, many small-scale, mixed farmers prefer using their own farm seed. The quality of these farm seeds is generally low as they are normally cleaned manually, so the final product still contains some unproductive seeds (broken seeds or small sized seeds). In addition, these seeds are sometimes attacked by pests and diseases as they are not treated. The results of using these poor-quality farm seeds are low forage yields and quality and low income.



Fig 1: Traditional and manual seed cleaning by woman farmer (Photo: Zied Idoudi, ICARDA)

To tackle this constraint the CRP livestock (feed and forage flagship) in collaboration with the IFAD funded CLCA-II Project, promoted the use of innovative locally produced seed cleaning and treatment units to develop business for lead farmers and farmer cooperatives around forage seed production. After discussing with national partners (INRAT¹, OEP², INGC³), the business idea was found more suitable for small or medium SMSA (Mutual Association of Agricultural Services/Société Mutuelle des Services Agricoles) as the machine would benefit more farmers. SMSA are a kind of farmers' cooperatives providing services to their members. The cooperatives can provide seed cleaning and treatment services for their members. The business can help to provide additional income for the cooperative and forage seed production of their members. The seeds are used by the members themselves.

Low cost feed supply is a major constraint for small scale livestock farmers in Northern, Central and Southern Tunisia, in particular during summer. Through grinding of locally available feed the intake will be increased, digestibility is improved and productivity gained. In 2019, the CRP livestock "Feed and Forages flagship" in collaboration with the IFAD funded CLCA-II Project has introduced in Tunisia the technology of locally produced mobile grinders which can serve for feed mash production as well as simple grinding of bulky feed like straw and hay and a range of other agro-industrial feed resources to reduce feed wastage and provide alternative diets for the summer feeding of flocks.

MATERIALS AND METHODS

This paper is providing a technical description of two-locally manufactured machines co-developed to support small-scale, mixed farmers in the crop-livestock systems of North West Tunisia in improving the efficiency of on-farm forage seed production and the feeding of their livestock. An illustration of the benefits issued from these machines to farmers and farmers cooperatives will be provided in the results section. It is important to mention that the development of these machines is undertaken through different steps including:

- ✓ Field investigation and characterization of small farming systems components. This leads to the identification of technical gaps which can enable transformative change in the farm system we are working on. We mainly focused on crop-livestock system, as the focus of our program is mainly on "feed and forages".
- ✓ Identification of any available and affordable technical solutions currently existing in the market. If this is not the case, we then go for:
- ✓ Co-design and co-development of an affordable technical solution which can be relevant and accessible to small farmers. Small farmers are usually involved in this design stage.
- ✓ Sub-contracting machinery manufacturer (who also contribute to the design) given the budget thresholds,

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- ✓ Testing and piloting the developed machines at the farm level, through field and demonstration days while monitoring its robustness in addition to any feedbacks from farmers and other technical partners,
- ✓ Once the previous step is validated, we then proceed with the distribution of a small number of machines to a network of farmers and farmer's cooperatives. A business plan is further developed to provide more evidence about the usefulness and profitability of the machines. Only farmers and cooperatives who are willing to partly (financially) contribute to the price of the machine are considered.

The remain of this section provides some technical characteristics of the “mobile seed cleaning and treatment unit”, and well as the “mobile feed grinder machine”.

l) The mobile seed cleaning and treatment unit: Technical characteristics and performance

One-unit costs 12,500 TND (about 4,350 US\$) and has a capacity of about 0.8 t / hour depending on the kind of seeds treated. It is produced by a local Tunisian blacksmith and can be operated by electricity (220 V). The unit comes with four different sized sieves which allow the cleaning of different sized seeds (barley, faba beans, vetch, berseem, etc.). It also contains an additional part to treat seeds against fungal diseases. The two wheels give flexibility to the use of the unit as it can be attached and moved by a car to facilitate its movement from one site to another.



Fig 2: :Mobile seed cleaning and treatment unit (Photo: Zied Idoudi, ICARDA)

l) Small-scale feed grinder to improve the quality of roughage feed

The grinder can chop and grind material like cactus cladodes and fruits, small olive branches and leaves, straw, hay, date kernels, cereals, faba beans etc. and works with both, electricity (380) V or PTO powered by a tractor. Just like the seed treatment unit, it can be moved easily by a tractor, hence giving the farmer the opportunity to chop the materiel next to the field or the flock yard where he has no electricity. Production capacity per day varies between 1.5 and 10 t mainly depending on the type of material to be chopped. The price per unit is 1,000 US\$ and It was produced locally by SFEMI society with the support of ICARDA.



Fig: 3 Training in use of mobile feed grinder (Photo: Udo Rudiger, ICARDA)

The machine has been introduced to farmers in June 2019 whereas the seed treatment units have been distributed only end of 2019. Since then, ICARDA with its national partner OEP are closely monitoring the use of the machines.

OEP and ICARDA developed monitoring sheets for both technologies to collect data concerning different indicators like costs, return and benefit. We also looked at the different management systems by the different beneficiaries. The final objective is to identify different business models around the technologies and see to which extent they can be beneficial for users.

RESULTS AND DISCUSSION

1) The mobile seed cleaning and treatment unit

Four mobile seed cleaning and treatment units were delivered and distributed to farmers' associations having between 150 and 350 members each and are located in different CLCA target areas (North Western and Central regions of Tunisia) – globally, over 1,000 small-scale farmers will benefit directly from these units during the upcoming years. Young farmers and women were also considered among the beneficiaries

With the help of the mobile seed cleaning and treatment unit, members of these four cooperatives can significantly increase their seed quality and consequently their fodder production. In addition, the unit can serve as an income generating activity for the cooperative as farmers have to pay renting fees to use the machine. Beneficiaries, who have been carefully selected based on their interest and need for the machine, contributed with 10 % of the total price of the machine (1,250 TND/435 US\$), which is used to train them on the machines and on other good practices for seeds production and cleaning in general. The 10 % contribution was also considered as essential for farmers participation and engagement.

The distribution of the machines served to enhance small businesses of the recipient farmers' cooperatives. Cooperatives started to rent them at a negotiated cost to their member farmers and generated additional income for the cooperatives. Table 1 shows the potential of this technology and the engagement of all four cooperatives in using the units. The treated seeds were to a large extent forage cereal like barley; legume forage seeds like vetch and faba beans were also recorded.

During this short period of use, a total of 66 tons of seeds were cleaned only and 173.6 t cleaned and treated. A total of 138 farmers benefited from the four units. The total benefit for these four cooperatives with about 2,000 TND (682 US\$) is not significant as the intention of some cooperatives during this first experience was rather to attract members using this service than making a profit. This explains the different service prices varying between 10 TND and 35 TND for cleaning 1 t of seeds and 50 – 80 TND for treating seeds. Service prices will be adjusted once the demand and market are created.

Table 1. Use of seed cleaning and treatment unit by four farmer cooperatives (SMSA) in November and December 2019

SMSA	Qtt Seeds Cleaned (t)	Qtt Seeds Treated (t)	Cleaning Price (TND/t)	Treatment Price (TND/t)	Return	Total Benefit (TND)	Number of Users (Farmers)	Number of Potential SMSA Users
El Amen	24.2	0	35	N/A	847	315	12	320
El Felah	4.7	42.6	10	80	3,455	-13	20	200
Ettaouen	14.6	131.1	20	70	9,469	1467	95	350
Melyen	22.5	0	20	50	450	225	11	150
Total	66	173.6	N/R	N/R	14,221	1,994	138	1,020

All four cooperatives employed one person on a temporary basis to make the unit functioning. Some cooperatives assigned the unit to be stationed at the cooperatives' base; others allowed the farmers to take it and use it at the farmers' site. In all cases, it was the cooperatives' employee who was responsible for manipulating the unit. The SMSA Ettaouen which used the machine for almost 150 t of seeds is already considering the purchase of a second machine as the demand is high and the processing period limited. A hybrid system will be adopted whereby one unit will be placed permanently at the cooperatives site and the other will be allowed to move from farmer to farmer.

II) Mobile feed-grinder machine

Besides the seed cleaning and treatment units, ICARDA donated twenty mobile grinders to 12 young entrepreneurs and eight farmers associations in Northern, Central and Southern Tunisia. The beneficiaries contributed with 10 % (300 TND / 110 \$) and used the machine to develop their feed and / or compost business.

More than 3,000 beneficiaries including young farmers and women are now benefiting from this equipment. Recipient farmers' associations were carefully selected based on their interest and need for the use of the machine to develop their feed and / or compost business. These grinders can lead to reducing costs and thus increasing income. It is an ideal tool for smallholder farmers to improve their incomes which represents an opportunity for improved livelihoods in traditional small-scale farming. The use of these tools reduces the labor time spent on feed-farming operations especially for women farmers.

Each cooperative developed its own management strategy for the use of the grinding machine. For example, the cooperative SMSA "Ettaouen" in Siliana, North-West Tunisia, with 350 members, uses three different management models:

- a) If the farmer is a member **without a tractor** he can ask the cooperative to come and chop his feed **at his farm** using the cooperative's tractor and driver. In such a case he pays 30 TND / hour (approx. 10 US\$). This includes tractor rent, tractor drivers wage and petrol.

- b) If the farmer is a member **with a tractor** he can use the grinder with it **at his farm** but he has to pay 25 TND / day (8.3 US\$) for the cooperatives grinder technician (operating the grinder with his tractor) and 15 TND / day (5 US\$) for the cooperative as renting fees for the grinder which is used for maintenance of the machine. Petrol charges are at farmer's cost.
- c) The farmer can also use the **cooperatives tractor** and grind his materiel **at the cooperatives warehouse**, bringing along his feed to chop. In such a case he pays 3 TND (1 US\$) per 100 kg of feed irrespective of its nature (barley, hay, straw, etc.)

The SMSA "Ettaouen" has so far provided service to 40 members of their cooperative and employed one person on a part time basis, depending on the demand. The objective of the cooperative is rather to provide services to their members and attract new farmers to join, than making benefit with the machine. So far, the model (a) has been mostly requested.

The farmer organization SMSA "Serj-Weslet" in Ouslatia, Central-West, Tunisia has only 46 members but focuses also on service provision to non-members in order to generate revenue for the cooperative. They are operating this small side business for six months and estimate their monthly net benefice at 150 TND (50 US\$).

CONCLUSION

The efforts undertaken by ICARDA and its national partners in identifying the demand, co-designing, and co-developing locally adapted machinery solutions appropriate for small farming systems is proving to be highly effective and beneficial. Similar self-sustained and institutionalized innovation processes are unfortunately rare in Tunisia. Most of the technologies available to farmers are rather imported or developed without strong concertation with the different stakeholders and mainly the end users.

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