Lessons learned of five years feed and forage technology transfer in Tunisia (2016 – 2021)

1. Introduction

The quality and quantity of forage produced coupled with the unbalanced feeding of livestock in rural Tunisia is not sufficient and stable enough to ensure high quality red meat production of small ruminants. This lost opportunity can be addressed through the adoption of diversified feeding regimes that are based on locally produced feeds and by-products.

The CRP livestock 'Feed and Forages" in Tunisia has aimed to develop business around different feed and forage technologies. This was done in collaboration with other GIZ funded bilateral projects like the "Red meat value chain" and the "Mind the Gap" project.

The technologies promoted were as follows:

- Feed blocks
- Pellets
- Mashed feed
- Mobile forage seed cleaning and treatment unit

2. Feed and forage technologies

2.1 Feed block production

2.1.1 Background and project support

Feed blocks are a solidified mixture of agro-industriel by-products (AGIBPs) like olive cakes, wheat bran, tomato and citrus pulp, overripe cactus fruits, apples and dates combined with a binder (e.g lime), a preserver (salt), Urea (source of Nitrogen) and a mineral mixture. They are used as catalytic supplements for low quality diets (e.g cereal straw, low quality hay and pastures) to stimulate digestion thereby improving the productive and reproductive performance of small ruminants. The use of feed block is expected to improve the feeding cost and feeding productivity. From an environmental perspective, making feed blocks is considered a simple and cost-effective option to valorize perishable AGIBPs (tomato pulps, olive cakes, etc) that would otherwise become an environmental hazard.

Figure 1: Manual production of feed blocks using mold (Udo Rudiger/ICARDA)

Feed blocks were not new in Tunisia. Already in the 80's several projects introduced this technology. Those projects promoted the feed block production by using manual means of production with the help of a mold.

Farmers were trained and advised to produce their own feed blocks. Unfortunately, the technology never took off due to this labor-intensive production method.

ICARDA's "Red meat value chain" project promoted the idea of producing feed blocks in a semi-industrialized way to avoid the "labor-intense production" constraint. A feed block manufacturing unit (FBMU) was developed in collaboration with a Tunisian metal manufacturer which could produce up to 5 tons of feed blocks per day. The project idea was to encourage private enterprises to produce and sell the feed blocks to smallholder livestock farmers.

Figure 2 : Feed block manufacturing unit and produced feed blocks (Ali Nefzaoui/ICARDA)

The project purchased four FBMU and selected the following four different types of FBMU beneficiaries to see which one manages best the production and commercialization of the blocks:

i) A young dynamic **start-up** very interested in the feed block technology
ii) An apple producing **farmer cooperative** who wants to add value to the overripe apples
iii) A well-established cactus fruit processing **enterprise** who wants to add value to the peels
iv) A well-established feed **trader** who wants to diversify his feed portfolio

The FBMU costed about 13.000 US$ and the beneficiaries were asked to contribute 10% of the value in form of produced feed blocks.

All four enterprises were trained in the manufacturing technology of the feed blocks using the FBMU as well as in the development of a feed block business plan. The calculation helped to determine the production cost and sale price of one-ton feed blocks. Depending on the availability of the necessary ingredients the production costs varied between 300 and 350 TD / ton (approx. 100 – 117 US$).

In order to stimulate the demand for feed blocks we selected this technology in ICARDAs "Mind the Gap" project which looked at how different dissemination methods influence the adoption of a technology. 560 farmer households were invited to technical, economical and organizational trainings concerning feed blocks. They also received technical SMS messages on a weekly basis.

Figure 3: Farmer field day "Goats fed on feed blocks" (Udo Rudiger / ICARDA)

2.1.2 Results

Over three years after distributing the FBMU and training the four beneficiaries of the machines, none of them has started producing and selling feed blocks on a regular basis. The reasons for this are multiple. Some are reasons are general, others are individual.

2.1.2.1 Individual reasons of FB manufacturer for non-adoption

- The farmer cooperative is not producing due to internal management problems. The managing director wants to use it as its personal business while the cooperative wants to use it as a common business (as initially planned). The machine has never been set up. After several project interventions with the national partner organization OEP[1] the machine was taken away from the cooperative and handed over to a private feed producing enterprise in the same town. Up to know he also hasn't started producing (one year after reception of the machine) due to dispute with the national partner organization over access to a grinding machine.
- The young engaged start-up is a very sad case. He rented a warehouse where he intended to produce the feed blocks. He had to wait nine months until the public electricity company STEG finally installed the 380 V connection, which is needed to make the FBMU functioning. Once it was installed, he wanted to set up the FBMU. As he was in a rush after paying nine months' rent without income, he set up the machine without professional assistance. During this process, part of the FBMU fall over him and killed him.
  The machine was then handed over to another feed producing young entrepreneur who usually produces silage in bags. He started producing feed blocks on a demand basis. In the first three months he reached 5 tons / month ordered by his neighbors who provided him with some needed ingredients. Unfortunately, his whole business collapsed half a year ago as he was selling silage on credit to farmers who didn't respect their engagement.
- The well-established cactus processing enterprise claims that he is disappointed with the performance of the FBMU. According to him it requires too much labor as it is only semi-industrialized (at least three persons) and the production capacity doesn't reach the promised 5 tons / day. It only produces about 2 tons/ day. After a trial period he stopped production.
- The trader claimed that he needs access to wheat bran which is a common ingredient for many feed block formulas. The wheat bran is a political issue, as it is a highly subsidized feed for farmers and feed producing companies. After a difficult project intervention, he received 5 tons of bran

[1] Office de l'Elevage et des Pâturages (: Livestock and Pasture Agency)

but claimed that he needed a long-term regular quota for the bran before he gets engaged in regular feed block production. He also sees the government as the main buyer of the blocks.

2.1.2.2 General reasons for non-adoption of feed blocks by manufacturer and farmers

General reasons for the failure of feed block technology in Tunisia are as well on the demand side as on the supply side. The projects had tried to stimulate both sides but could not overcome existing constraints.

On the demand side we tried to convince farmers of the benefits of the technology through trainings and demonstrations. The project even offered the purchase of feed blocks at a subsidized rate of 300 TD / ton. But only 2 % of the targeted farmers took the offer and purchased the offered feed blocks. Major reasons for the low adoption and demand rate given by farmers are as follows:

- Farmers prefer subsidized feed like barley and wheat bran.
- Barley sold at 450 TD / ton has a higher energy rate (1 FU) as compared to feed blocks (0.7 FU)
- Wheat bran, a commonly used supplementary feed, although less nutritious as feed blocks, is much cheaper (250 TD/ton)
- The project subsidized price of 300 TD / ton is considered as too expensive (Market price will not be below 450 TD / ton)
- Farmers don't trust the composition. The ingredients lime and Urea can be harmful to the animals if not administered in the right way. Farmers fear loss of their stock.
- The sustainable availability of the feed blocks is not guaranteed as none of the four producers have got engaged in regular production. Changing diet too often is not recommended.
- Organizing transport to collect feed blocks is a challenge
- Farmers have the impression that blocks are not succulent enough to attract animals (which is true at initial stage; animals need time to get used to the new feed).
- Feed blocks tend to rot if not dried and stocked properly.
- Size of the blocks is not suitable for all farmers (too big) and are difficult to handle
- Feed blocks tend to brake once they drop, leading to wastage.
- Farmers are conservative and not too open for innovative feed.

General reasons on the supply side as follows:

- Commonly used feed by livestock farmers like wheat bran and barley grains is subsidized by the government. Making new feed like feed blocks economically sustainable and generate income for feed block producers and sellers is difficult as they cannot compete with the subsidized feed.
- Ingredients or by-products necessary for feed blocks like olive cakes and cactus fruit pulps are only available during a certain period of the year, which reduces the production period of blocks.
- Changing formula along the year according to availability of by-products requires higher transport costs and makes profitability even less likely
- Access to wheat bran which is an important part of many feed block formula (10 – 20%) is very difficult for small scale feed producers like our four cases. Governmental regulations for distribution of subsidized wheat bran focus on two target groups: i) livestock farmers, they obtain a certain quota according to the number of animals, ii) large scale feed producing companies

respecting all kinds of norms and hygienic regulations (which are difficult for our small scale enterprises to fulfill)

- There was few support of governmental institutions to promote the feed block technology as their level of conviction was and remained low.

2.1.3 Conclusion

The selection of FBMU beneficiaries could be improved through demanding a financial contribution of at least 10% in cash right from the beginning to create ownership and see whether the beneficiaries are really interested in this technology and business (and not only the value of 10% to be delivered in feed blocks, which then finally never happened). The introduction and presentation of the FBMU technology to potential feed block entrepreneurs should have been intensified. The simple presentation of a video and pictures showing the use of the FBMU is not enough for these entrepreneurs to really know what they will be engaged in. We should have invested more time in the selection process and show each candidate the FBMU and practice the production with them before taking the final decision. A better collaboration with national extension services and listening to their experiences and advices would have also helped to avoid this failure…..but to make this happen and develop proper sustainable feed business cases we would have needed a project timeline of at least three years, and not only 18 months as in the "Red Meat VC project."

2.2 Pellet production

2.2.1 Introduction

As the feed block technology didn't succeed and adoption of this technology was low, ICARDA started in 2018 to research on the possibility of producing pellets made of locally available materiel and by-products. A survey with 700 farmers showed that most farmers are interested in this feed. Pellets made of Alfalfa are already known by farmers, but costly. The survey showed that there were two types of pellet machines available in Tunisia. One was an imported model with production capacity of 20 tons / day and price of about 30,000 Euro. The other model was locally produced with a capacity of 1 – 2 tons / day and price of 2,700 Euro. As funds didn't allow to purchase the expensive imported machine we opted for the locally produced machine, although from the technological side it wasn't perfect.

Figure 4: Locally manufactured pellet machine (Udo Rudiger/ICARDA)

2.2.2 The locally manufctured pellet machine

Figure 5: Pellets produced from local materiel (Udo Rudiger/ICARDA)

The machine has a grinder integrated for chopping straw, cactus cladodes, etc . It uses 380 V as source of energy. Major constraint is the low production capacity and lack of an integrated drying facility. Pellets need to be dried in open air on sheets or on the ground with risks of contamination and need for extra working hours and space.

A business model calculation showed that a minimum sale price of 600 TD / ton (approx 200 US Dollars) would be needed to use local pellet production as a business case. Nevertheless, this must be taken very cautiously as it implies that farmers are willing to pay that much. One should look at prices of alternative feed like imported certified concentrates which costs about 1.000 TD / ton or subsidized barley grains with an UF of 1.0 , which cost only 450 TD/ton. ICARDA stopped working on this model in 2019 due to low perspective of success.

2.2.3 Imported pellet machine

In 2020 ICARDA discovered a new type of pellet machine in Tunisia. The representative of Juhaina, a Chinese based company, imports different sized pellet machines for one year and assures after sale service with spare parts and repair. The machines work with 220V or 380 V depending on the size. Production capacity varies between 110 kg / hour (for 2.200 TD / 700 US$) and 3000 kg / hour (26.000 TD / 8.600 US$).

Juhaina already sold eight different sized pellet machines in Tunisia. One of the clients is a large-scale farmer who produces his own pellets for his small and large ruminants. He uses the following composition: 30% olive cakes + 20% faba beans + 10% soy cakes + 20% wheat bran + 20% barley. The farmer estimates the production cost at 470 TD / ton. This rich compound feed can easily compete with imported concentrates sold at around 1000 TD /ton. The machine he uses has a capacity of 100 kg / hour. He doesn’t claim having any problem with the machine.

Figure 6: Pellets produced by imported pellet machine (Udo Rudiger/ICARDA)

2.2.4 Conclusion and way forward

The locally manufactured pellet machine doesn't perform in such a way that it allows to develop business with this technology. Production capacity is too low. It might be interesting for a local farmer to produce his own feed if he is ready to invest in time for drying the pellets. But the investment costs for a small-scale farmer are high and discouraging.

ICARDA proposes therefore to further research and develop pellets produced with an imported Chinese model. We ordered one of these pellet machines to be further tested and used for trainings in collaboration with the national partner OEP. If results are positive a larger machine with a capacity of about 500 kg /h will be ordered to supply a farmer cooperative and enable them to produce pellets for their own members and generate income.

2.3 Mashed feed

2.3.1 Introduction

In 2019, The CRP livestock "Feed and Forages" has introduced in Tunisia the technology of mobile grinders which can serve for feed mash or compost production as well as simple grinding of feed like straw and hay to reduce feed wastage.

ICARDA donated twenty (20) mobile grinders to 11 young entrepreneurs and 9 farmers associations in Northern, Central and Southern Tunisia.

The grinders can chop and grind materiel like cactus cladodes and fruits, small olive branches and leaves, straw, hay, date kernels, cereals, faba beans etc. and work with both, 380 V or PTO powered by a tractor. Production capacity per day varies between 1.5 and 10 t, depending on the materiel to be chopped. This locally manufactured machine costs 3.000 TND (1.050 US$) per unit.

Figure 7: Young entrepreneurs using mobile grinders to develop their business (Udo Rudiger)

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, feed loss will decline as no selective feeding takes place, digestibility and nutrient intake will be increased, and productivity gained.

The young entrepreneurs contributed with 10 % (300 TND) and use the machine to develop their feed and / or compost business. They either produce and sell the final product or they provide grinding services to farmers.

Figure 8: Small scale feed grinder to improve the quality of roughage feed (Zied Idoudi/ICARDA)

2.3.2 MATERIALS AND METHODS

It is important to mention that the development of the business using grinding machines has been 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 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 mainly developed the design) given the budget thresholds,
- ✓ 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.

2.3.3 Results

2.3.3.1 Entrepreneurs case study

After seven months of using the machine, one of the eleven young entrepreneur Hathem, based in Chebika, Kairouan managed to obtain a turnover of 58.800 TD (20.500 $) and a gross benefit of 11.200 TD (3.900 $) through the production and sale of compound feed (1/3 barley, 1/3 maize, 1/3 faba beans). In addition, he offers grinding services with which he gained 2.100 TD (730 $) in the same period. He rents a small shop with his counterpart to carry out both services, where he had to pay fixed costs for rent and electricity of 3.150 TD (1.100 $) for the seven months, thus leading to a net benefit per month and person of 725 TD (250$). Not bad for a start. The young entrepreneur Hathem intends to purchase a grinder with greater production capacity.

Figure 9: Agripreneur preparing balanced feed rations by using the grinder (Udo Rudiger / ICARDA)

2.3.3.2 Comparing business cases of entrepreneurs and cooperatives using grinders

Table 1: Entrepreneurs and cooperatives using grinders for their business

Name and place of entrepreneur/coop	**Mefthahi Saddem, Sbitla, Kasserine**	**Adel Ben Amor-Tozeur**	**Cooperative El Maraài, Douz**	**Cooperative Green, Kef**
What is your product?	Grinding service and Animal feed	Grinding service	Grinding service	Grinding service
How do you operate it (380V and/or tractor)	380 V	380 V	380 V	380 V and tractor
What ingredients do you grind?	Barley, straw, old bread, soy, maize	Dates by-products, barley, luzerne, straw, palm leaves	Dates by-products, barley, luzerne, straw, palm leaves	Orge barley, faba beans, hay, straw, wheat, sorgho, cactus, olive branches
When did you start your business?	August 2019	September 2019	July 2020 (no access to 380V and magazine)	July 2019
At which price do you offer your service / product	*Grinding Service*: -straw bale: 2TD/20kg -old bread: 1TD/bag *Product:* -animal feed:0.8DT/kg	220 Dt / ton (200 kg/ h)	20 DT / ton	20 DT/day renting fees
Number of person employed (temporary or permanent)	No one	Family members (temporary)	One permanent (450 DT/month), incl other tasks than grinding	No one
What benefit do you make per day/ ton?	*Grinding Service:* -straw bale: 1.5 TD	190 DT/ton	No benefit intended	20 DT/day

	-old bread: 0.75/bag *Product:* *-animal feed:0.1DT/kg*			
How many kg / tons have you already sold/grinded?	Grinding Service: -30 tons *Product:* -5 tons	52 tons (42 t auto-consumed and 10 t service)	300 kg / day (average) 9 ton / month	22 clients x 1.5 days = 33 days
Total Benefit	*Grinding service* -1,500 TD *Animal feed* *-500 TD*	*Grinding service:* 1,900 TD	Grinding service: No benefit, only service for members	Grinding service: 660 DT
Number of clients	*Grinding service:* 40 *Animal feed:* 5	Grinding service: 6	*Grinding service:* 60 members of cooperative	*Grinding service:* 22 members of cooperative

The above table shows how different grinders are used by individual entrepreneurs and cooperatives. Number of beneficiaries vary between 6 and 60; grinded materiel varies according to agro-climatic zone and available vegetation, total benefit between 0 and 2,000 TD for the production period, and grinding service charges vary between 20 TD/day and 220 TD/ton. The different charges depend on the objective of the grinding service (just providing services for members of cooperative without intention to obtain benefit or intended benefit) as well as the feed supply situation in the region (very scarce in the south).

2.3.3.3 Two cooperatives - case studies

The grinder also serves farmer cooperatives and associations to provide services to their members and generate income to their organization. Every organization develops its own management strategies for the use of the grinding machine. For example, the cooperative SMSA Ettaouen in Siliana, North-West Tunisia, with 120 members uses three different business models:

i) If you are a member **without a tractor** you can ask the cooperative to come and chop your feed **at your farm** using the cooperative's tractor and driver. In such a case you pay 30 TD / hour (approx. 10 US $). This includes tractor rent, tractor drivers wage and petrol.

ii) If you are a member **with a tractor** you can use the grinder with it **at your farm** but you have to pay 25 TD / day (8.3 US$) for the cooperatives grinder technician (operating the grinder with your tractor) and 15 TD / day (5 $) for the cooperative as renting fee for the grinder which is used for maintenance of the machine. Petrol charges are at farmer's cost.

iii) You can also use the **cooperatives tractor** and grind your materiel **at the cooperatives warehouse**, bringing along your feed to chop. In such a case you pay 3 TD (1 $) per 100 kg irrespective of its origin (barley, hay, straw, etc)

The SMSA Ettaouan has served so far 40 members of their cooperative and employed one person on part time, 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 i) has been mostly requested.

The farmer organization SMSA Serj – Weslet in Ouslatia, Central-West, Tunisia has only 46 members but focuses also on service providing for non-members to create revenue for the organization. They estimate

a total of 100 farmers in their region being interested in this new service. Their only business model is similar to model i) of SMSA Ettaouen, but price composition is different. They charge 30 TD (10 $) for grinding 1 ton of cereals or 25 TD (8.3 $) for one hour chopping of straw, hay, olive branches, cladodes, etc. In addition, they charge the farmer 2 TD per kilometer as the cooperative will send a tractor driver using the coops tractor plus the grinder to the farmer. The cooperative pays 4.5 TD (1.5$) / hour to the tractor driver. They are operating this small side business for six months and estimate their monthly net benefice at 150 TD (50 $).

2.3.4 Conclusion

The different examples prove that the mobile grinder technology can be used to develop an income generating activity for farmers, entrepreneurs and cooperative. It can be used to produce and sell a product like animal feed or compost or to provide paid services. Some cooperatives use it rather as an additional service for their members to stimulate membership than making additional benefit.

Farmers feeding chopped feed benefit in multiple ways. They have up to 40% less feed wastage, gain time and through better digestibility better absorption of nutrients, hence better productivity, and income. For example, a farmer pays 1.5 TD for grinding one bale of straw worth 6 TD. He invests 25% of the straws value when paying for the grinding service but gained 15% of the straw value through reduced wastage; not to mention the gain he obtains through better absorption of nutrients.

2.4 Mobile forage seed cleaning and treatment unit

2.4.1 Introduction

The conventional national seed system in Tunisia is not providing enough quality forage seeds. Forage seed production like barley, faba beans or luzerne is mainly done by two large seed producing state-cooperatives who are subcontracting with individual farmers. Only one private seed enterprise and OEP are equally engaged in professional forage seed production.

Due to insufficient forage seed supply, but also to save costs, many small-scale 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 low income.

2.4.2 Project intervention

To tackle this constraint the CRP livestock feed and forage project promoted the use of innovative locally produced seed cleaning and treatment units to develop business for lead farmers and SME around forage seed production. After discussing with national partners (INRAT[2], OEP and INGC[3]) the business idea was found most suitable for small or medium SMSA (Societé Mutuelle des Services Agricoles) as the machine would benefit more farmers. SMSAs are a kind of farmer 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.

Figure 10: Mobile seed cleaning and treatment unit (Zied Idoudi/ICARDA)

A local manufacturer in collaboration with ICARDA and its national partners in Tunisia designed and developed a prototype of a "mobile seed cleaning and treatment unit" which has been locally manufactured at low cost. One unit costs 12.500 TND (about 4.200 US$) and has a capacity of about 800 kg / hour depending on the kind of seeds treated. Four (4) units have been delivered and distributed to four SMSA having between 150 and 350 members each and are in the Central and North-Western region of Tunisia (on average, over 1,000 small-scale farmers can benefit directly from these units).

With the help of these mobile seed cleaning and treatment unit, members of these farmer 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. The project monitors and coaches these associations to see how this unit is managed in an economically sustainable way. Beneficiaries, who have been carefully selected based on their interest and need for the machine, contributed with 10 % (1.250 TND / 435 US$). The 10 % contribution is considered as a proof of farmers motivation and engagement for getting the machine and using it in its operations. Financial contribution of beneficiaries is essential to create ownership.

2.4.3 Results

The first training day was organized in October 2019 at INGC, with the presence of other national partners of ICARDA such as OEP, CRDA[4]) and AVFA[5]. A demonstration of the machine by the local manufacturer and by the ICARDA-INGC team was done during this reception event.

In 2020 the manufacturer of the seed cleaning and treatment unit (machine) has visited the four cooperatives each twice to do necessary adjustment and assure good functioning of the machine.

[2] INRAT = Institut National de la Recherche Agronomique en Tunisie (National Agricultural Research Institute)
[3] INGC = Institut National des Grands Cultures (National Institute of Field Crops)
[4] CRDA= Commissariat Regional de Développement Agricole; (Regional department for agricultural development)
[5] AVFA = Agence de Vulgarisation et de la Formation Agricole ; (Agricultural Training and Extension Agency)

Table 2: Use of seed cleaning and treatment unit by four cooperatives (SMSA) in 2019 and 2020

		2019					2020		
Cooperative (SMSA)	Number of Coop members	Qtt Seeds Cleaned only (t)	Qtt Seeds cleaned and treated (t)	Cleaning / Treatment Price (TND/t)	Total Benefit (TND)	Number of Users (Farmers)	Qt seeds cleaned and / or treated	Total Benefit (TND)	Number of Users (Farmers)
El Amen	320	24.2	0	35	315	12	38.4	575	21
El Felah	200	4.7	42.6	10 / 80	-13	20	60.8	1,520	33
Ettaouen	350	14..6	131.1	20 / 70	1467	95	480	11,520	220
Melyen	150	22.5	0	20 / 50	225	11	111.7	3,594	25
Total	1,020	66	173.7	N/R	1,994	138	690.9	17,209	299

The above table shows the evolution of the use of the units from October 2019 to November 2020. The total quantity of cleaned and treated seeds increased from 240 tons to 691 tons; the total benefit for all 4 SMSA from almost 2,000 TND to over 17,200 TND and the number of users from 138 to almost 300.

The difference between the level of benefit per SMSA depends amongst other things on the cooperative's marketing strategy. Some coops like to maximize the benefit to invest in other technologies and offer more services, like the SMSA Ettaouan. Others, like the SMSA Melyen don't aim to maximize their profit but rather to satisfy the needs of their members at low costs and attract more members. SMSA El Felah did a combined strategy. In 2019 they offered many services (like transport of the machine) free of charge, leading to a loss in 2019. In 2020 they changed the strategy and obtained the highest benefit per ton of cleaned / treated seeds of 25 TD /ton, followed by Ettaouen with 24 TD/ ton.

All four cooperatives employed one person on a temporary basis to make functioning the unit. Some cooperatives led the unit be stationed at the cooperatives' base, others allow the farmers to take it and use it at the farmers' site. In any case it was the cooperatives employee who was responsible for manipulating the unit.

The SMSA Ettaouen which used the machine to improve almost 150 t of seeds in 2019 and 480 t in 2020 is already considering the purchase of a second machine as the demand is high and treating period limited. One unit will be placed permanently at the cooperatives site and the other will be allowed to move from farmer to farmer. Hence, a second person will be employed on a temporary basis during the seed treatment period (July – December).

The project also supports the integration of legume crops into the crop livestock production system to make it more sustainable. Sensitizing and training farmers convinced them to increase legume production. The lack or insufficiency of legume forage seeds on the Tunisian market motivated the cooperatives to produce their own legume forage seeds with the help of the mobile seed treatment unit.

In July 2020 the four farmer cooperatives have received additional special sieves for the seed treatment unit. These sieves have different sized holes and allow the cooperatives to clean a variety of different sized forage legume crop seeds like faba beans, berseem and vetch.

A total of 11 sieves (2-3 per coop) were co-financed by the project. As cooperatives are increasingly satisfied with the technology, ownership has increased; hence the project subsidy could be reduced to 50% of the sieve prices. One additional sieve costs 800 TD (2700$).

Figure 11: Different sized sieved for legume seeds (Udo Rudiger/ICARDA)

Table 3:Different forage crop seeds cleaned by cooperatives in 2019 and 2020 (in tons)

	barley	wheat	faba beans	oats	vetch	berseem	Total
SMSA Melyen	18	66	25	25	0	0	134
SMSA Ettaouan	205	395	0	26	0	0	626
SMSA El Amen	5	42	7	0	9	0	63
SMSA El Feleh	0	90	7	0	8	2	107
Total	228	593	39	51	17	2	930

The table above shows that a total amount of 930 tons have been cleaned by the four cooperatives since acquisition of the machines. Cleaning and treatment with fungicides are mainly done for wheat seeds, other crops are cleaned only. In 2019, mainly wheat and barley seeds were improved. Through the distribution of different sized sieves in 2020, the cleaning of 58 tons of legume seeds (faba beans, vetch, berseem) was realized.

Figure 12: Changing sieves, cleaning unit in action, cleaned seeds (Udo Rudiger/ICARDA)

2.4.4 Challenges and Conclusion

After two seasons of seed cleaning (2019 and 2020) farmers have identified another challenge. The increasing number of tons of seeds to be cleaned makes it very tiring and exhausting for the machine manipulating worker. He must lift the bags of uncleaned seeds to the entering funnel at the top of the machine which is about 2 m above the ground.

Seed bags weigh around 50 kg. A single person can't do it on its own for long time. Additional labor is needed, which makes the operation more costly. The solution will be the development of a "conveyor screw" which will transport uncleaned seeds from the ground to the entering funnel. The conveyor screw will not only reduce the workload for the employee but also save time and increase production per hour, hence more farmers can benefit from the machine in the future and more benefit can be generated for the cooperatives. It is expected that the conveyor screw will double its capacity.

Figure 13: Conveyor screw for see transportation

The manufacturer of the four mobile unit has already developed a prototype of a conveyor screw. Three of the four cooperatives are interested in this essential additional implement, necessary to improve production capacity of the unit.

The price per conveyor screw is 4,300 TD (1,600 $). The cooperatives will contribute again with 50% of the price. Just like for the new sieves this contribution shows that it's a real need from the farmers. The project has ordered three conveyor screws which will be available in February 2021; well before the next season starting in July 2021.

3. Lessons learned

3.1 Lessons learned regarding feed block technology in Tunisia

The feed block technology is technically feasible and can contribute to increase productivity of small ruminant production. It is a complementary feed which can replace concentrates and improve the digestibility of feed as it contains more roughages and crude fiber. Industrial and semi-industrial produced feed blocks are very successful and widely adopted in countries like India as they are highly subsidized. For it to become adopted by Tunisian small-scale livestock farmers it needs a shift in the national agricultural policy. As long as barley and wheat bran are highly subsidized by the government, they will remain the main supplementary feed. The production costs of feed blocks are too high (300 – 350 DT / ton) which makes this feed not competitive with the subsidized feed. But as the adoption rate was low even with project subsidy it would need a lot of additional training and sensitizing effort by the national extension service to convince farmers of tis technology. To summarize, the feed block technology in Tunisia can be assessed as not suitable under the present conditions.

3.2 Lessons learned regarding pellet production in Tunisia

Pellet production has a lot of scope in Tunisia. Farmers are used to this form of feed, for example you have lucerne pellets on the market. Pellets are easy to store, to handle and to ration. They don't brake like feed blocks and are well packed and labeled. As the example of the large scale-dairy farmer shows, it has competitive advantages compared to imported concentrates. Pellets composed of a grinded mixture of locally produced crops like barley and faba beans and agro-industrial by-products like olive cakes and imported products like maize and soybean are a high value feed for large and small ruminants. Pellet production with imported reasonable Chinese pellet machines with a capacity of at least 500 kg / h can be an interesting business model for farmer cooperatives and local entrepreneurs. The presence of an importing company which assures after sale service with spare parts and maintenance of the pellet machines makes it a sustainable solution. To summarize, development agencies and extension services in Tunisia should invest in this promising technology.

3.3 Lessons learned regarding mobile grinder technology in Tunisia

The experiences gained with the 20 grinders distributed to entrepreneurs and cooperatives show that the grinder can be very useful as a means for producing and selling products and to provide grinding services to generate income. It is used to produce and sell a variety of products like animal feed, compost and date kernel oil for cosmetic products. Farmers who are served with grinding their feed can reduce their production costs. Less feed is wasted, and absorption of nutrients increased. The fact that the already locally available grinder was modified through project intervention to become mobile and operated by a tractor driven PTO implement increases the scope of its utilization. Farmers can now use it with a tractor to chop crop residues next to their field for mulching or adding organic matter to the soil or chopping cactus cladodes next to the field or flock to provide additional feed. The advantages of grinding feed were not well known by many farmers. Sensitizing and training activities by the project increased the demand for these machines. To, summarize, this technology should be wider propagated. But for business development on a larger scale, grinders with higher capacity are needed.

3.4Lessons learned regarding mobile seed cleaning units in Tunisia

This research and development project enables farmer cooperatives to generate income and improve the seed quality of their members. Through different sized sieves the cleaning of forage legume seeds is made feasible, improving quality and quantity of produced forages in Tunisia. Monitoring of the use of the machine through project staff and national partners, taking into account farmers remarks and suggestions, helped to continually improve the machine and make seed production interesting for other actors. To summarize, it is a very promising technology which should be scaled so that other farmer cooperatives and entrepreneurs can become engaged in the seed cleaning business and improve the forage seed sector in Tunisia. An opportunity for development agencies, extension services and development banks.

3.5 General lessons learned

Three out of the four introduced technical innovations which aim to improve the feed and forage sector in Tunisia can be rated as successful and promising. The local pellet production, chopping of organic matter with a mobile grinder and local seed treatment of forage seeds are technologies which offer job opportunities in rural areas, income creation for entrepreneurs and cooperatives, reduce production costs and foster higher income for farmers.

These technologies were not developed from scratch through the conventional research and development concept with stages of “discovery – prove of concept – piloting – scaling”. ICARDA’s project team and local partners rather jumped on locally existing technologies, adapted, and improved them to better respond to farmers’ needs. The fact that the machines needed for the technologies are produced locally and, in the case of the imported pellet machine have a local distribution branch, assure a sustainable functioning of the technology. The technologies are simple, repair is easy and spare parts are available. Most general mechanics can solve eventual problems.
Through continuous monitoring and collaboration with the end users, like farmers, entrepreneurs and cooperatives, the technology could be assessed, and improvements introduced. The regular feed back of the end users were taken into consideration and together with the local manufacturer the machines were adapted to real needs.
In the case of the feed block technology many resources could have been saved. Agricultural research tends to look too much at technical aspects. There is no doubt about the nutritional value of feed blocks and the positive impact on sheep and goat’s growth and reproduction rate, when administered in the right way. But research should look more at economical aspects of a technology and specific agricultural political environment and regulations (e.g. subsidy of alternative feed) before promoting a new technology. We should have been more participative and ask national partners, farmers and their associations concerning their preferences beforehand. A short feasibility study could have helped to avoid disappointments; but the short project period of 18-months didn’t allow all this.

The examples have shown that participation of different actors at different stages is essential for successful introduction and scaling of innovations and business development. Donors should take this into account when financing research and development projects and attribute enough time for planning and implementation.

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