Targeted INRA pulses breeding product profiles: ongoing work, achievements and limits for large use by farmers and food industry

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FSD7 workshop 30 October to 3 November 2022, Marrakech (Morocco)

Outlines

- Brief introduction of pulses in Morocco and INRA research program
- Main results for targeted product profiles of the INRA Morocco pulses research programs
- Limits to scale up the use of pulses' varieties by farmers and food industry

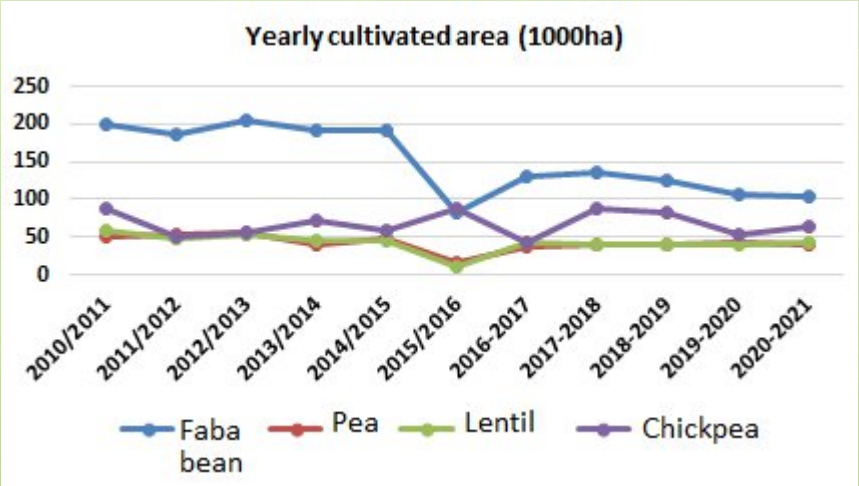
❑ Brief introduction of Pulses in Morocco and INRA pulses research program

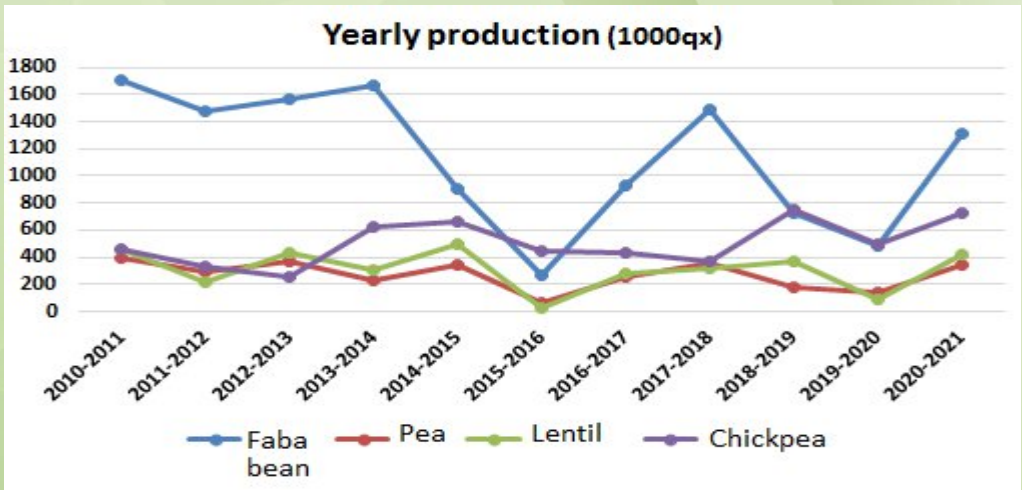
Improved food security

Improved nutrition and health

Sustainable farming

Improved livelihood





(ONICL 2022)

Average cultivated area : 350 000 ha; **Average production** : FB 120 000 t; C 48 000 t; L 27 000 t;
Average importation : 29 000 t/an; **Average yield** : 8 qx/ha; **Average consomption**: 8 kg/hab/an

INRA Morocco pulses research program

Five research axes

- ✓ **Pre-breeding, breeding and biotechnology**
- ✓ **Agronomy & IPM**
- ✓ **Grain quality and valorization**
- ✓ **Value chain analysis**

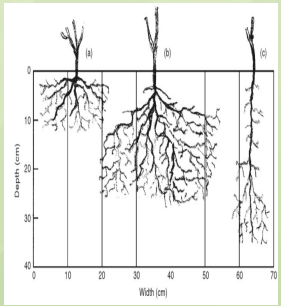
Main objective :

Contribute to the rehabilitation and development of pulses in Morocco through **research on breeding, agronomic management, plant protection, mechanization and products valorization**

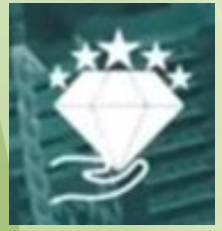
In line with the ambitions of the national strategy (Géneration Green 2020-2030)

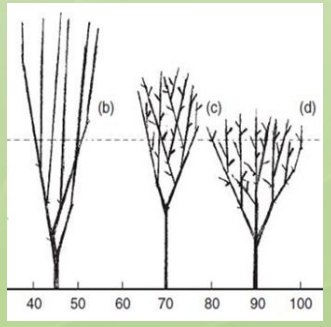
Targeted research product profiles

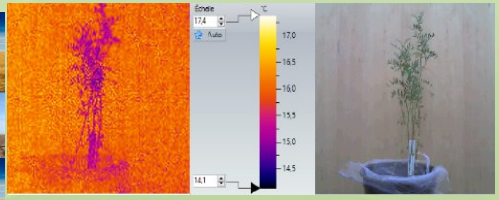
Farmers/Consumers/Food industry needs



Quality/Pulses based Products/Processing with higher added value







- **Main results for targeted product profiles of the INRA Morocco pulses research programs**

❖ Variety development : genetic gain

10 faba bean improved varieties registred:

- Moderatly resistante to Botryris and Ascochyta;
- Low pod dehiscence;
- > 30 qx/ha
- > 25 % yield advantage over the local check Lobab

Zina (Fv705)

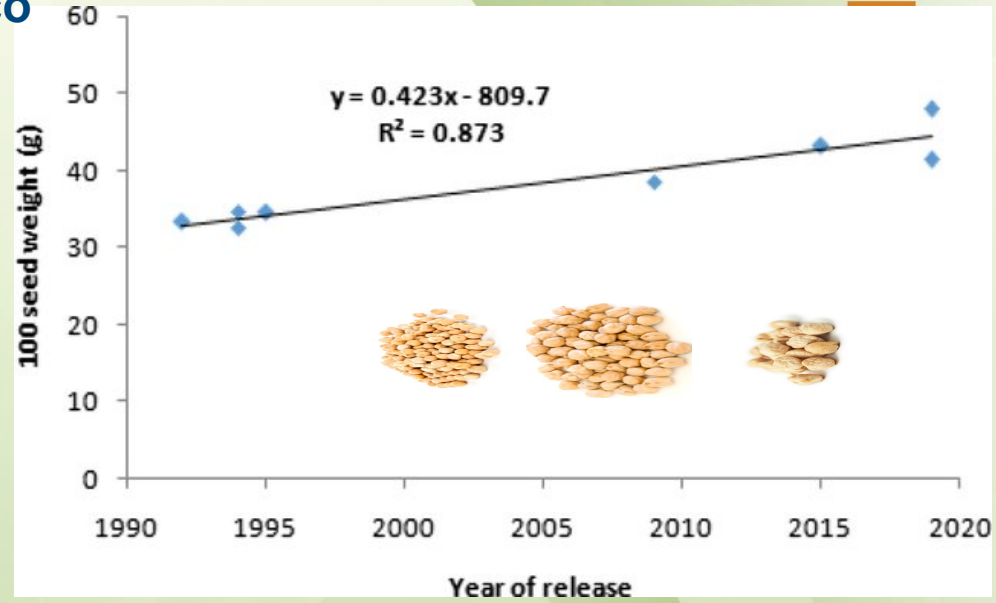
Hiba (FH1031)

Breeding Progress for Chickpea Grain Yield and Seed Size in Morocco

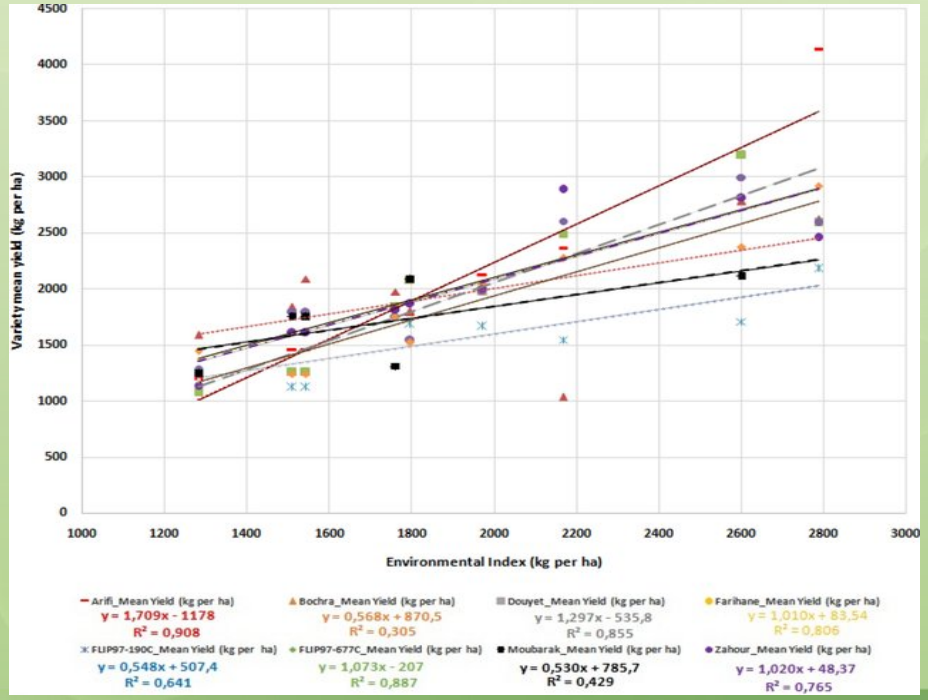
Six winter-type chickpea varieties evaluated under 9 different environments

From 1990 to 2019: Hundred seed weight was improved from 33 to 47 g

A clear increase in **seed size**, an **important market trait for chickpea in Morocco**, is observed in the more recent improved varieties. The improvement in seed size had limited penalty on yield.



Genetic progress for 100-seed weight from Moroccan winter chickpea varieties



Most varieties had wide adaptation and responded positively to the increase in environmental index.

Houasli et al. (2021), Euphytica **217**, 159 (2021

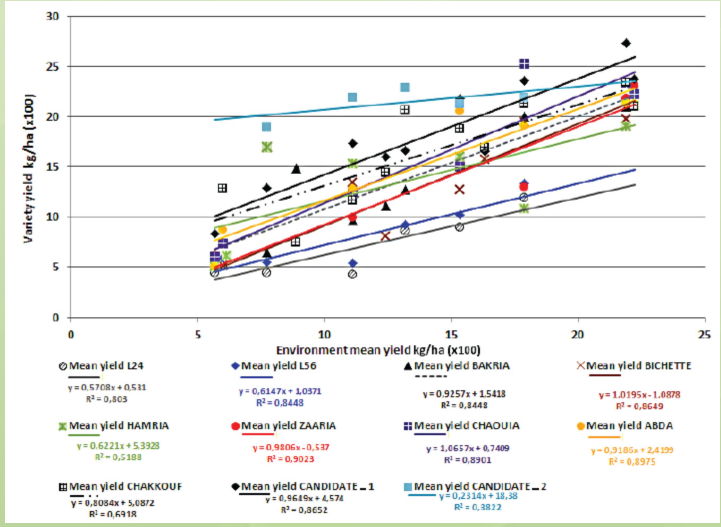
Breeding Progress for Lentil Grain Yield in Morocco

11 lentil varieties evaluated in 14 different environments:

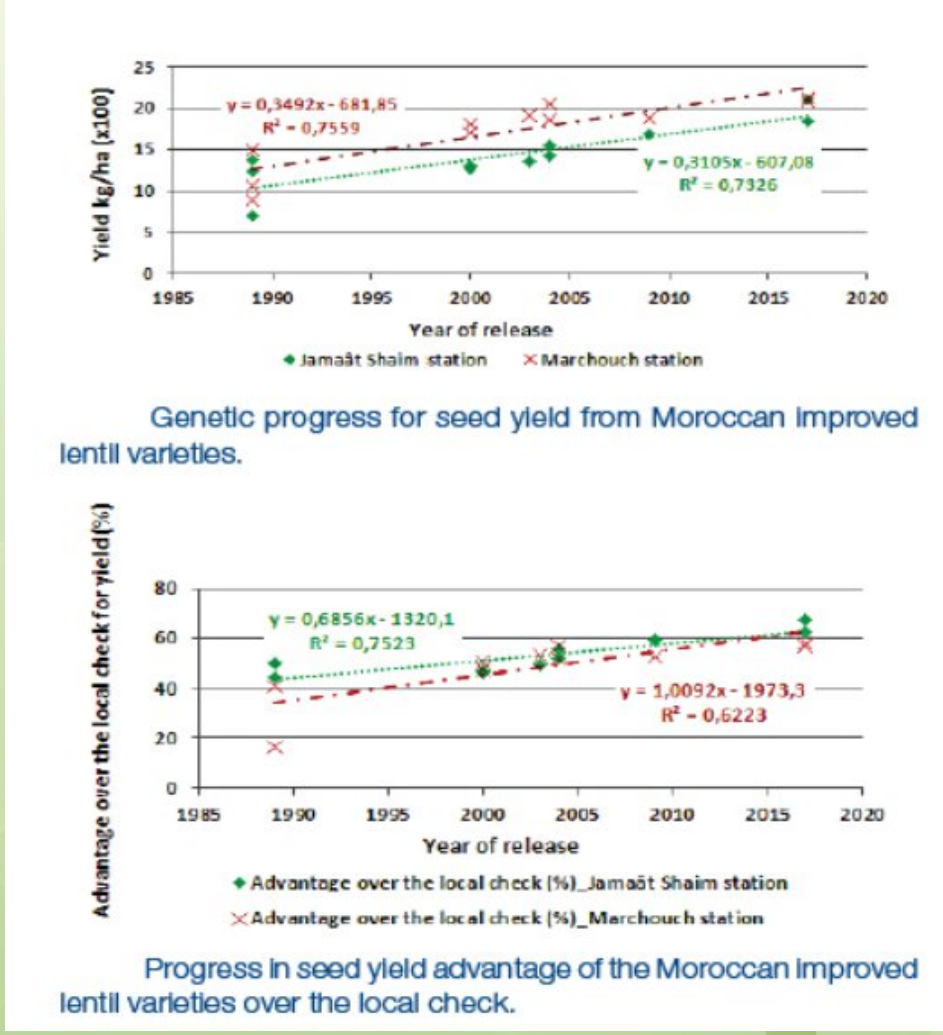
Significant increase and higher genetic gain over the local check were observed from 1989 to 2018.

Up to 35 kg/ha/year genetic gain for grain yield was obtained.

The yield advantage of improved varieties over the local check increased from 16 to 67% from 1989 to 2018.



Most of varieties have wide adaptation and respond positively to the increase of environmental index.



Genetic progress for seed yield from Moroccan improved lentil varieties.

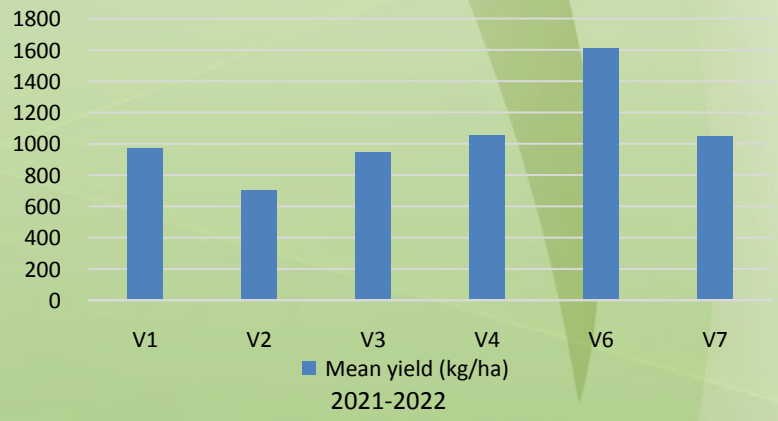
Progress in seed yield advantage of the Moroccan improved lentil varieties over the local check.

Idrissi et al. (2019). Crop Sci. 59:1–12 (2019)

Participatory approach with farmers: farmers willing/needs first !

Pertes à la récolte !

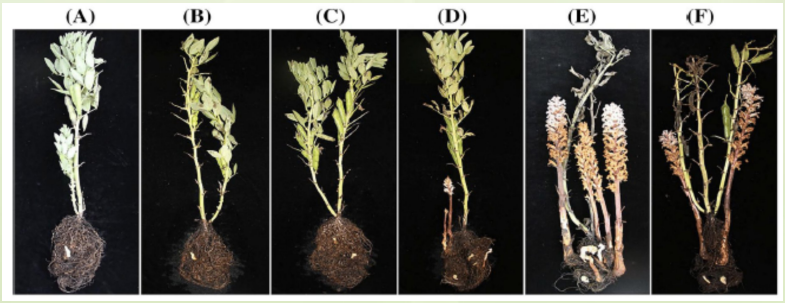
- 21-2022: 35 – 40 %
- 20-2021: 15 -18 %



❖ Integrated pest management

Tolerante Sensitive

(Briache et al. 2019)



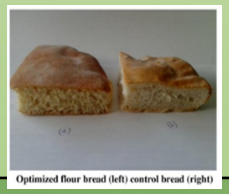
Orobanche tolerant faba bean accessions

Selection of the most effective chemical fungicides against chickpea Ascochyta for reducing disease severity and improving yield. Used in integration with varietal resistance

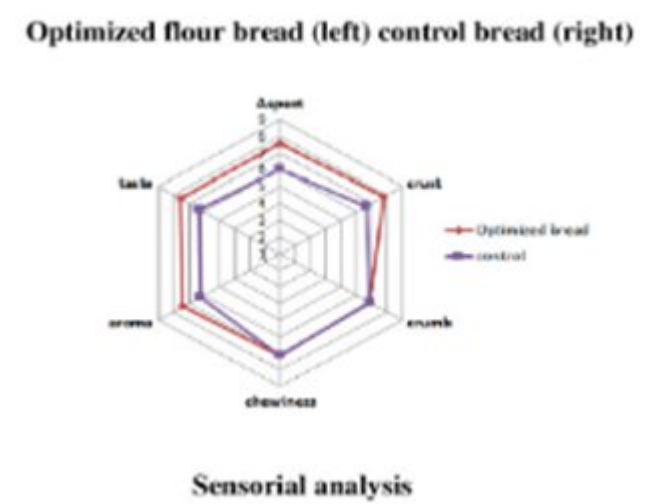
Fungicides	Garbanzo (S) (qx/ha)	Rizki (MR) (qx/ha)
Check	0	18.72
Mancozeb 80%	0,08	15,12
Flutriafol + Carbendazime (117,5 + 250)g/l	0,06	26,48 (+43%)
Chlorothalonil + Carbendazime (500+100)g/l	0,32	26,44 (+43%)
Azoxystrobine (250 g/l)	0,07	27,24 (+47%)
LSD(0.05)	4,55	

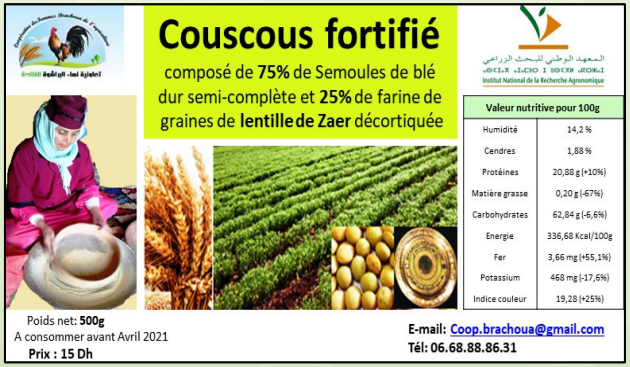
(Krimi Bencheqroun et al, 2016)

❖ Composite functional food products based on pulses – wheat grains developped

Cooked meals	- Bissara - Laâdas - Loubia - Hamous Marocain	
Conserved food	- Chickpea - Peas	
Biofortified Moroccan Couscous	- Biofortified Couscous (faba bean 30% - 50%) - Biofortified Couscous (lentil 30% - 50%) - Biofortified Couscous (chickepa 30% -50%) - Biofortified Saikouk (50% chickpea)	
Biofortified Moroccan Pastries (Fekkas,…)	- Biofortified sweet/salted Fekkas (50% faba bean) - Biofortified sweet/salted Fekkas (50% lentil) - Biofortified sweet/salted Fekkas (50% chickpea)	
Pulses' flour	- Lentil flour - Chickpea flour - Faba bean flour	 
Biofortified Bread	- Chickpea – wheat - Lentil - wheat - Faba bean – wheat - Chickpea – wheat – milk powder	  

Nutritional, sensorial, technological proprieties and acceptability studied





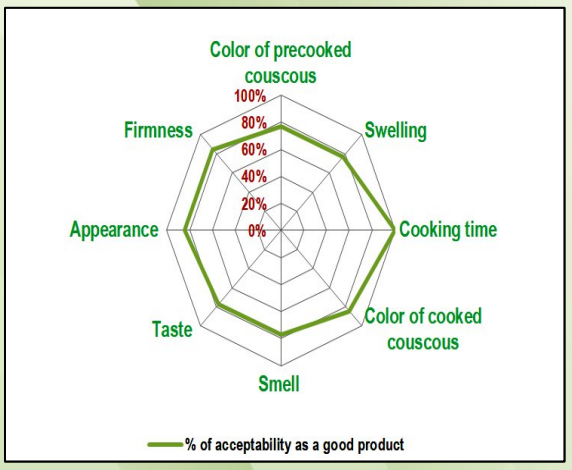


Table 1
Physicochemical characteristics of whole durum wheat flour, whole faba bean flour and their mixtures (g.100 g^{-1} DM).

Flour ratios		Parameters				
WF	FF	MS	CA	CP	CFb	CF
100%	0%	9.54 ± 0.40	1.97 ± 0.08	11.40 ± 0.16	3.48 ± 0.28	1.80 ± 0.20
75%	25%	9.87 ± 0.63^{NS}	2.03 ± 0.08^{NS}	14.00 ± 0.10*	3.60 ± 0.50^{NS}	1.40 ± 0.20^{NS}
70%	30%	10.48 ± 0.12^{NS}	2.09 ± 0.02^{NS}	15.07 ± 0.45*	4.20 ± 0.96^{NS}	1.33 ± 0.41^{NS}
65%	35%	10.50 ± 0.26^{NS}	2.11 ± 0.01^{NS}	15.77 ± 0.50*	4.39 ± 0.50^{NS}	1.33 ± 0.30^{NS}
60%	40%	10.53 ± 0.12^{NS}	2.19 ± 0.02*	16.53 ± 0.30*	4.60 ± 0.74^{NS}	1.08 ± 0.07^{NS}
0%	100%	11.48 ± 0.40*	2.77 ± 0.10*	20.73 ± 0.26*	8.00 ± 0.32*	1.07 ± 0.30^{NS}

WF: whole durum wheat flour; FF: whole faba bean flour; MS: moisture; CA: crude ash; CP: crude proteins; CFb: crude fibers; energy value (kcal.100 g^{-1} in dry weight). NS: not significant ($p < 0.05$) and *: significant ($p < 0.05$) according to Tukey's test.

Table 2
Mineral compositionof whole durum wheat flour, whole fa

Flour ratios		Parameters	
WF	FF	Fe	Zn
100%	0%	3.90 ± 0.10	4.80 ± 0.28
75%	25%	4.60 ± 0.23^{NS}	4.89 ± 0.40^{NS}
70%	30%	5.04 ± 0.03^{NS}	4.96 ± 0.18^{NS}
65%	35%	5.10 ± 0.30^{NS}	5.07 ± 0.23^{NS}
60%	40%	5.77 ± 0.90*	5.21 ± 0.18^{NS}
0%	100%	6.99 ± 0.58*	5.42 ± 0.30^{NS}

WF: whole durum wheat flour; FF: whole faba bean flour.

Benali A, En-nahli Y, Noutfia Y, Elbaouchi A, Kabbour MR, **Gaboun** F, El **Maadoudi** EH, **Benbrahim** N, Taghouti M, Ouhssine M, Kumar S. Nutritional and Technological Optimization of Wheat-Chickpea- Milk Powder Composite Flour and Its Impact on Rheological and Sensorial Properties of Leavened Flat Bread. Foods. 2021; 10(8):1843. https://doi.org/10.3390/foods10081843

A **Benayad**, M Taghouti, A **Benali**, Y Aboussaleh, N **Benbrahim**. **2021**. Nutritional and technological assessment of durum wheat-faba bean enriched flours, and sensory quality of developed composite bread. S. J of Biological Sciences.

❖ Value chain analysis

SWOT analysis

Annexe 1. Forces, Faiblesses, Opportunités et Menaces du secteur des légumineuses alimentaires

Forces

- Fonction alimentaire : taux élevé de protéine pour l'alimentation humaine et animale développer et maîtriser ;
- Fonction socioéconomique : Pratiquée essentiellement par les petites et moyennes exploitations agricoles, elles participent à la création de l'emploi et à la gestion de la trésorerie en périodes de pointes ;
- Fonction agronomique : fixation de l'azote de l'air ; restitution d'azote et d'autres éléments minéraux à la culture suivante ; apport de matière organique ; diversification de la rotation ; et rupture des cycles de maladies et de ravageurs, etc.
- Fonction environnementale : protection des eaux contre les fuites de nitrates ; protection des sols contre l'érosion ; et stimulation de l'activité biologique des sols ;
- Capitalisation des acquis de recherche et de R&D obtenus dans le cadre de partenariat entre des institutions nationales et internationales.

Faiblesses

- Absence de stratégie et de politique publique spécifique au secteur ;
- Faible maîtrise des techniques de production et faible utilisation des semences certifiées ;
- Problèmes de maladies et parasites ;
- Non mécanisation des travaux de récolte et d'entretien ;
- Faible qualité des produits ;
- Faible rentabilité des cultures ;
- Insuffisance de l'encadrement et du transfert de technologies ;
- Faible intervention des organismes de stockage dans la commercialisation et la collecte ;
- Grande variabilité des prix ;
- Marché oligopolistique ;
- Absence d'organisations professionnelles et interprofessionnelle ;
- Agro-industrie encore embryonnaire.

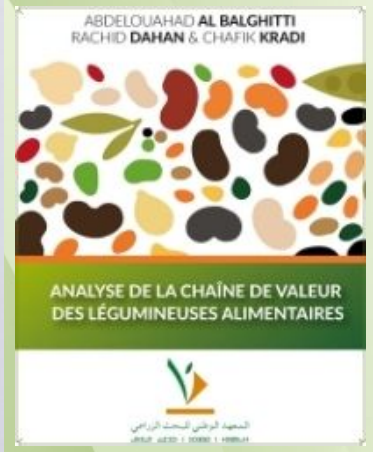
Opportunités

- Marchés intérieur et extérieur prometteurs (légumineuses et engrais azotés) ;
- Existence de barrières à l'entrée ;
- Prise de conscience progressive des risques liés à la durabilité des systèmes de culture à base de céréales ;
- Nouvelle stratégie agricole (PMV) ;
- Nouvelle stratégie de conseil agricole.

Menaces

Aléas climatiques ;

- Ouverture des frontières suite aux accords de libre-échange et concurrence à l'égard des importations ;
- Effets des mesures de soutien et d'incitation adoptées en faveur des cultures concurrentes.



(Al Balghitti et al./ Badraoui et al. 2020/Laamari et al, 2020)

- **Limits to scale up the use of pulses' varieties by farmers and food industry**

Pre-breeding, breeding and applied biotechnology

INRA pulses research program

Axis 1

Other INRA projects

Axis 2

Value chain analysis/Socio-economics

Axis 3

Axis 4

Agronomy & IPM

Grain quality and valorization

Innovations & Technology Transfer INRA project

Partners

Research results

Impact

Weakness	Potential alternatives /actions	Actors / Partners
Professional representative : weak organization	- **Strengthen** the specific **inter-professional actors organization** dedicated to the 'grain legume sector'; - **Acknowledge** their interest for agricultural sustainability and develop **specific program-contract**	**All stack holders/Public policy**
Poor seed system/Low availability of certified seeds	**Alternative seed systems/ Subsidies**, **Supports** and Subventions…	Public policy; Research institutes; Inter-professional organizations, **Seed Companies**,…
Limited use of available good practices (small scall farmers)	Promotion of **good agricultural practices** (Crop protection, etc.) Communication/Extension	
limited and shy valorization of food products derived from legumes grains; low competitiveness of national products	More **investment** at both **small and large scale**: more **marketing** for national/local products, **more perspectives and innovation for food industry** (new products, more specific for agri-food industry, for specific consumers "bio fortified **cookies/candies** for children", etc…);	Millers, Farmers' cooperatives/associations, **Companies, Manufacturers** (mixed flour, bread, couscous, cookies, pasta,….)
More research (Pre-breeding, breeding, plant protection, innovation …) is needed	**Further research** for resistance/tolerance for **recalcitrant biotic and abiotic traits** that require more fundamental research/laboratory work;	**Universities**, **research institutes**, **Companies**

المعهد الوطني للبحث الزراعي
ⵓⵙⵜⵉⵜⵓ ⵏⴰⵚⵉⵔⵜ ⵏ ⵜⵙⵙⵏⵜⵉⵡⵉⵏ ⵜⵉⵖⵔⵉⵙⵜ
Institut National de la Recherche Agronomique

Screening for drought tolerance under field conditions in a drought and heat stress prone research station of INRA Morocco (Jemaât Shaim station with an annual average rainfall of 330 mm; altitude 180 m, 32.35° N, 8.85° W).
Picture: O. Idrissi season 2018-2019

Thank you