Suitability and Identification of Pulses in Cropping Systems for Nutritional Security, Better Livelihood and Mitigation for Climate Change: Need for on-farm experimentation and minimum datasets for modelling for out-scaling of the production system

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Regional Dialogues on the International Year of Pulses: Concept Note for discussion

Focus:

The objectives of the RD are to:

- Understand/Document the "state-of-the-art" on pulses in each Region in terms of opportunities and challenges, including existing policy environment
- Agree on common priorities for advocacy and promotion of pulses in each region.
- Identify knowledge gaps and research needs

Source: DRAFT notes on Regional Dialogues on IYP, FAO

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Pulses:

- Protein rich
- Form the part of regular meal with diverse preparations
- Income favored
- Adapt to marginal lands
- Diverse in cropping duration– respond to photoperiod and soil moisture
- Basis of sustainability of several Cropping systems

Challenges and opportunities: Look for options

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Pulses for Nutrition and Health

- Protein rich
  - overcomes malnutrition
- All the pulses
  - Biofortified lentils, detoxified grasspea/ICARDA
- WANA region:
  - Chickpea, lentil, faba bean, mung bean

- Semi-arid tropics
  - Pigeon-pea, cow-pea, mung bean, grass-pea

Sources:

https://www.icarda.org/crop/lentils, …/chickpea, …/fababean, …/grasspea

Unpublished: Sarker et al. (on-going study). Screening micro-nutrients (Fe, Zn) responsive lentil genotypes in Bangladesh, Nepal, India, Ethiopia and Morocco).

Jitendra Kumar et al. (2016). Agric. Food Chemistry. /Lentil

Consuming pulses: Form the part of regular meal in diverse preparation

Human: **Hundreds of food- preparations**
Chickpea: **Houmus, falafel, samosa, numerous other snacks**
- **Daal (part of regular meal)**

Lentil: **Soup, daal**
Faba bean: **foul, green pods**
Pigeon-pea: **Daal, green pods/leaves as vegetable**

Ruminants: **Many fodder preparations**
Feed: **Feed-blocks barley-legumes , popular in Iraq, Syria, Lebanon, India**

Pulse consumption → Likes/taste →

1. Habit &Health → increased acreage → enhanced research → increased productivity & production → Nutritional security
2. Reduced meat consn. → reduced methane gas → favorable CC

✓ **Show and Tell: Organize Culinary demonstration cross-cultures and geographies**

Sources:
https://www.icarda.org/update/lovepulses-product-showcase-virtual-competition
http://www.101cookbooks.com/ingredient/lentil ; …/chickpea; …/fava%20bean

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Adapted to marginal lands

- **Lentil**
- **Grass-pea**

High input responsive crops…

- **Chickpea,**
- **Faba bean,**
- **Pigeon pea**

➢ **Genetic and agronomic options**

Diverse in cropping duration– respond to photoperiod and moisture availability

- All the legumes

Case of Chickpea , in CWANA: Sowing seasons (ICARDA materials)

- Spring sown (conserved soil moisture but terminal drought), improved genotypes available with ICARDA
- Winter sown almost twice the yield of the spring sown
- Dual season (Winter and Spring) season genotypes identified

- Larger plot sizes, less diverse environments greater success for dual season

✓ Recommendation: Go for Dual Season material, 300-500 mm rainfall

Sources:

- Malhotra et al. (2007). Euphytica.
- Imtiaz et al. (2013). Crop Science

- **Genetic Options for Climate Change**

- **Chickpea:**
  - **Sudan- heat and drought stress (Amel/Malhotra)**

- **GWAS, GS in legumes ?**

- Identification of Genetic makeup interaction with CC and building up Genomic Selection

✓ EXPLORE MORE:

- A large project on GxE interaction for enhancing productivity
  - diversified environments wrt biotic, abiotic and edaphic factors
  - Quality phenotyping and genotyping
  - Model for business as usual – genotype based
  - Productivity prediction model using marker, pedigree information, GS for CC

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Pulses in cropping system

- **Sole cropping**
  - Riskiness due to biotic stresses
  - But easier harvesting and crop management

- Chickpea: Ascochyta blight (AB)
- Lentil: Fusarium wilt (FW) (Wilt sick plot screening, 577 accns. in 1993, narrowed to 88 accns. in 1994, dynamics of FW led to 'late wilters')

- Faba bean: Ascochyta blight (AB), chocolate spot (CS) and rust (R)
  - Multiple diseases (Screening from over 2000 accessions during 2005 -2012 at Lattakia, Syria -- high precipitation, high humidity and mild temperature)

✓ **Recommendation**:
- faba bean accns. for multiple resistance (AB+CS, AB+CS+R)
- Lentil accns. For FW

Sources:

Maalouf et al. (2016). Euphytica.
Bayya et al. (1997). Euphytica.

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Globally Coordinated Adaptation Trials

AEC – biophysical and climatological parameters based

Response based:

No global level Mega Environments have been characterized for pulses

(example: wheat by CIMMYT)

- ✓ **EXPLORE MORE:**
  - ✓ **Design a GxE interaction study for each pulse crop**
  - ✓ **Rationalize the environment /Mega Environments—global**
  - ✓ **Identify specifically adapted lines**

Sources:

Sarker et al. (2010). Crop Science
Sarker et al. (2007). Australian Journal of Agricultural Research.

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Pulses in cropping system

- Crop rotation
  - Barley/legumes, Wheat /legumes, Cereal/vetch or medics with small ruminants (ICARDA in Syria, Jordan, ….), Lentil in rice fallow,
  - Productivity and Sustainability
  - Longer a rotation, cumulative builds-up makes it more valuable for research on soil fertility and its interaction with climatic parameters, time to detect significant time trends,
  - Legumes an option for fallow and wheat monoculture
  - Barley–legume rotations in a typical Mediterranean agro-ecosystem
  - Forage and Food Legumes in a Wheat-Based rotation Under Drought-Stressed Conditions in Northern Syria's Medium Rainfall Zone
  - The role of feed legumes in long-term yield patterns in barley-based cropping systems in northern Syria

✓ Recommendation:

- Out-scaling of the crop rotations involving legumes

Sources:

Christiansen et al. (2015). Crop & Pasture Science Jones
Ryan et al. (2012). Archives of Agronomy and Soil Science
Christiansen et al. (2011). J. Agronomy and Crop Science.
Jones and Singh (2000). Journal of Agricultural Sciences(Cambridge).

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Pulses in cropping system

- Intercropping
  - ICRISAT
  - sorghum with pigeon-pea
  - Advantage of resources sharing

Sources:

Rao and Singh (1990). Field Crops Research.
Singh et al. (1988). Biometrics.
Singh and Gilliver (1988). Journal of Applied Statistics.

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Options for technology development, on-farm evaluation and out-scaling, impact assessment

- Technology development: genetic option… enhance it
- Identify the robust genotypes for yield and stability… enhance it
- Identify the cropping systems to fit legumes in with agronomic and crop husbandry practices

Research Data Quality

Capture numerous sources of systematic sources of variability: Experimental Designs, Statistical analysis (pre or post design)

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Biometrical and Statistical technics and tools
Research for Development:

Quality phenotyping:

- Replicated field trials, spatial pattern accountability, Optimal design for enhancing GG (heritability)

Multi-environment trials:

- Cross-over type interaction, specific adaptation, Cultivar superiority, inter-site transferability of genotypes

On-farm trials

- Productivity and riskiness

Bayesian approach in most of data analysis situations of ongoing experimentation

✓ **Include above in research plans**

Sources:

Sarker & Singh (2015). Field Crops Research.
Singh et al. (2015). Crop Science.
Omer et al. (2015). Comm. In Biometry and Crop Science.
Singh et al. (1996). Euphytica.

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- ✓ **Recommendation for D or R4D**

1. on-farm evaluation of legumes in monocrop, crop-rotation and intercrop
    1. Select the action-sites (diverse climatic and soil and community profiles)
    2. Design and data assessment for productivity and protein, and impact on income of the producer and health of the consumer
2. Response to the climatic variation– generation of minimum datasets/databases
    1. On-farm location
    2. Soil and weather variables (list of parameters)
    3. Develop models from on-farm data
3. Carry out scenario analysis for regions beyond action sites based on the models

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Thank you