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NISD GRASS PEA FOCUS REPORT

SUSTAINABLE DEVELOPMENT THROUGH TRANSDISCIPLINARY RESEARCH AND INNOVATION

Needs opportunities and challenges for improving grass pea: summary report

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Summary

Grass pea (*Lathyrus sativus*) is an underutilised crop with great potential for nutritious, climate-smart and regenerative agriculture. Interest has recently increased in grass pea research, and new resources have become available. This summary collates what researchers see as the needs, challenges and opportunities for breeding improved grass pea. Overall, there is a sense that momentum is gathering behind grass pea research, and building cohesive, strategic direction would accelerate this change. Researchers share concerns of how grass pea is perceived and funded but see opportunities to scale up research. New grass pea research resources play a role in these opportunities and the report shares key traits for breeding targets. The report concludes with suggested next steps to accelerate the delivery of improved grass pea in farmers' fields.

Introduction

Grass pea can grow on marginal soils, is highly resistant to drought, flood, pest and disease stresses and offers some of the highest protein concentrations of the legume family (around 30%). However, grass pea has challenges that prevent the crop gaining popularity. These include: 1. Presence of the toxin β-ODAP; 2. Limited breeding improvement; 3. Low market value. Most of these challenges can be addressed through rapidly improving grass pea. The John Innes Centre, James Hutton Institute and ICARDA are developing pre-breeding tools to support global grass pea research and improvement.

This study sought to understand the needs of grass pea farmers, breeders and researchers, to feed into breeding strategies

Section 1: Global snapshot

This section provides an overview of grass pea use, research and developments from the perspective of report respondents.

- **Grass pea cultivation is increasing.** While the crop harvests are often left out of official reports, the general consensus is that grass pea cultivation is increasing in South Asia and Ethiopia. There is increasing potential for grass pea cultivation in Europe.
- **There has been a recent increase in grass pea research attention.** There is growing research momentum for grass pea. Wider interests in new pre-breeding tools and climate-smart agriculture are adding to this.
- **There is potential for global collaboration to improve grass pea.** New breeding platforms offer a central collaboration core. ICARDA, John Innes Centre and James Hutton Institute are key nodes to proliferate access to these new resources.

Traits of interest

The grass pea community are focused on improving a limited number of traits. This small pool further justifies collaboration of efforts. The list of traits is as follows:

Low β-ODAP. Low β-ODAP levels were requested by nearly all respondents. Where this was mentioned, it was always articulated as 'consistently low across a range of habitat types'. Low levels should be throughout the plant.

Yield. Respondents felt that yields in grass pea are generally low and need improving. Yield increases can be achieved through increasing the number of pods, size of seeds and overall biomass.

Resistance. Grass pea is known for having good general resistance to biotic and abiotic stresses. Some respondents felt that grass pea had no need for further resistance improvements and that yield improvement traits should be prioritised. Drought, flood and salinity tolerance were all suggested. The main requested biotic tolerance improvements are against powdery mildew, orobanche and aphids.

Nutrition & processing. Nutritional traits in grass pea were almost all in reference to amino acid composition. Researchers suggested increasing protein content, accessibility and presence of methionine. Some suggested raising iron and zinc content.

Trait type	Trait
Toxicity	Low β-ODAP
Yield	Pod number Seeds per pod larger seeds biomass Early maturity
Abiotic resistance	Drought tolerance Flood tolerance Salinity tolerance
Biotic resistance	Aphid resistance Ascochyta blight Fusarium wilt Orobanche Pod borer Powdery mildew Rust Sclerotinia
Nutritional & processing	Increased protein content Improved protein bioaccessibility Increased macronutrients Increased methionine content Reduced cooking time

Section 2: Discussion points

This study uncovered common discussion points for the future of grass pea research. Interviews brought repeated challenges and needs for grass pea breeding. These include:

Focus on ODAP. β-ODAP dominates grass pea literature but respondents felt that the neurolathyrism risk story has become sensationalised beyond the actual risk. The conditions under which neurolathyrism occurs are rare and the disease reports remain rare despite increases in grass pea cultivation. Respondents felt that the dominance on β-ODAP attention has slowed general grass pea breeding progression. Future projects should consider breeding safer grass pea, but this must be as part of general breeding targets for improved yield and market value.

Obscurity in harvest data. The lack of field cultivation information makes it difficult to know exactly how much grass pea is being grown. The knock-on challenges are difficulty in tracking demand and the crop's general obscurity to wider audiences. Respondents felt that official reports need capture grass pea harvests, and this could be lobbied for.

Different locations, different research interests. While there is value in bringing the grass pea community together, different locations have different needs from the crop. These differences exist both in research interests and the user needs. European-based researchers have tended to focus on basic research to understand the plant, particularly the genetics. South Asian researchers have tended to focus on adaptive research and traditional breeding. There is a need to be mindful of these differences when bringing grass pea researchers together.

A lack of research time. There is a lack of grass pea dedicated researchers and breeders. Grass pea research is often part of an individual's paid

role and is often a lower priority legume than more lucrative options like chickpea. This poses a risk to the continuity of grass pea improvement.

A lack of cohesion. The grass pea community is friendly but tenuously connected at the global level. The network depends heavily on a surprisingly limited number of individuals (see figure 1). This poses a risk for collaboration, should those individuals shift from focusing on grass pea. Another challenge is that many researchers are not directly in touch with each other, despite often sharing similar interests. This disconnection reduces group learning across the network and raises the chance of duplication of efforts. Building more strategic links between research groups would reduce these risks.

Breeders and seed producers. Grass pea breeders were a main subject of discussion, but few researchers had contact with breeders. This poses a challenge as researchers regularly spoke of resources for breeders as a main pathway to impact. It risks resources not reaching breeders, or being ill-fitting with breeder needs. The ongoing needs of grass pea breeders need to be amplified in grass pea improvement conversations. Failure to do so could lead to challenges where deliverables may not match the reality of needs. An example of this can be found in the topic of genetic markers. Researchers felt that breeders want genetic (KASP) markers for grass pea traits. This rationale was based on genetic marker-assisted selection becoming commonplace for many crops. However, a major challenge is that breeders may not have the capacity to use newer forms of marker-assisted selection. There is a need to index grass pea breeders and their needs. ICARDA are best placed for this through their pre-existing links. Capacity needs of the breeders should feed into wider grass pea capacity improvement initiatives.

Caution around climate-smart hyperbole. Grass pea is a resilient crop and this a useful asset. However, like any other crop, grass pea will perform best under favourable conditions. There has been a tendency of grass pea proponents to report that it will yield under the harshest of conditions. While this can be the case, the yields will be lower and likely unsustainable for commercially focused farmers. There is a need to exercise caution in how resilience claims are made about grass pea.

Seed systems. The mechanism of getting improved grass pea to farmers poses challenges, with no certain solutions. Improved crops are conventionally sold on formal seed channels. Grass pea however is predominantly a crop of the poor and is sold on informal seed systems. If improved varieties are released on the formal seed system, they would need to offer farmers an appropriate economic return to justify the higher prices. However, for the poorest farmers, and therefore likely those most at risk of neurolathyrism, even marginal price increases might force them to choose unimproved grass pea from informal networks. State-supported supply systems might offer another approach, but risk sustainability if funding stops. Other, more participatory seed system options exist which could offer a sustainable and reliable way to get improved grass pea to all farmers. There might be value in further exploring where these participatory approaches have worked for other crops.

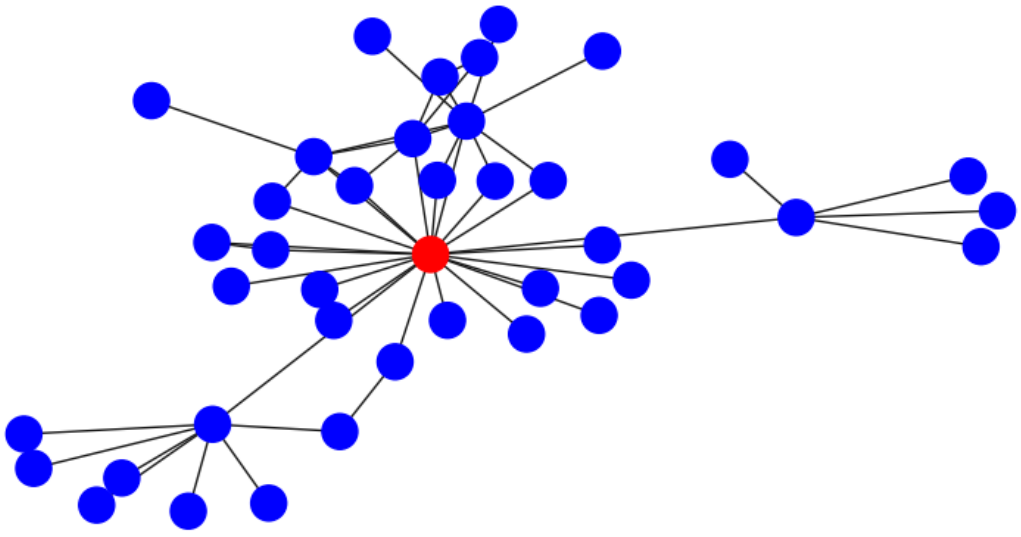


Figure 1: Graphical representation grass pea network connections at the individual level, as reported by respondents. The red marker shows a single individual at ICARDA.

Section 3: Next steps

The previous two sections demonstrate the potential for grass pea improvement, and the need for strategic delivery plans. The final section of this report outlines suggested steps for accelerated grass pea improvement.

Accelerating the research

Grass pea is still a neglected crop and requires breeding attention to unlock its potential. New breeding resources provide a chance to accelerate this process. These gains in time are particularly pressing given projected changes in climate that grass pea offers a resilience solution to. Understanding and controlling genetic variability is key to rapid breeding.

Grass pea currently has no genetic markers for breeders to draw on, but KASP and GWAS resources are being created. These tools would be most effective for faster trait discovery and introgression when used with the germplasm collections, Germinate repository, and speed breeding facilities. Together, these platforms could offer the core of accelerated grass pea improvement. There is a need now to:

- Create the pre-breeding resources in response to research needs;
- Raise awareness with users in how to access and utilise pre-breeding resources
- Build capacity with groups who wish to use the new resources.

Working more closely with farmers

From food to forage to regenerative cover crop, grass pea is set to be bred for very different ends. Each of these options caters to different farmers, with different goals, needs and acquisition methods. This poses potential gaps between what research outputs and delivery mechanisms, and what end users need. The following steps should be taken to test assumptions and improve design for end users:

1. Identify end users' needs and current (or potential) user journeys with the crop;
2. Clarify pathways to impact for each intended grass pea application and user group;
3. Share findings across the network for improved understanding of farmer needs.

Strengthening the community

There is a growing network around grass pea research but these clusters are loosely connected by few individuals. More connections need to be established across the network to improve resilience and flow of knowledge.

Meeting. A grass pea meeting is a high priority next step and there is enthusiasm to bring grass pea researchers together. ICARDA is well placed to host the meeting on account of its central role in the network. The meeting needs to cater for a range of interests in grass pea. This should include, research examples, new tools, breeder experiences and farmer engagement. A combination of general talks and specialist working session could ensure both breadth and depth to the meeting. Training sessions could be held around this meeting for those interested in accessing new research tools or methods. This might be a central hub of information, updated resources in response to feedback or joint funding proposals. Subsequent meetings should run every one to two years.

Improved grass pea Initiative. Grass pea research could be part of a much larger initiative. Such an initiative could unlock and drive grass pea breeding efforts, learning from other crop breeding initiatives. These larger initiatives are seen to bring collectivised action, greater pipelines to adoption and improved funding competitiveness. The initiative aim would be to move beyond creating literature and databases instead towards achieving new varieties in farmers' fields. The first steps should be to identify the overall impact and how the initiative will operate to achieve it. This mission plan should be used to structure and plan collaboration. Country and theme leads should be identified based upon partner expertise. Engagement between research groups must be at both individual and the institutional levels. Finding and connections at the grass pea meeting can feed into the initiative development.

Ongoing communications. Better lines of communication need to be established across the grass pea network. Doing so will improve flows of knowledge, develop the resilience of the network, prevent duplication of efforts and compliment collective research advances. There is a need to improve 'internal' and 'external' communication for grass pea research. Internal connections are intended to update individuals within the community. External communications are intended for audiences within and beyond the network.

Internal communications. The role of these connections would be to quickly share findings, developments and opportunities. Lines of communication should aim to 'pull' as well as 'push' information, encouraging ongoing engagement from community members. Researchers need to see value from contributing. Value could be presented through increasing exposure for career development and facilitating new collaborations. The research community would like regular virtual meetings. These could be held as a speaker series across various grass pea research components, followed by discussions and updates.

External communications. Grass pea is not well known, and this diminishes awareness of its potential. Where grass pea does appear in the public space, it is often with narratives that dwell on toxicity. This 'external' image of grass pea lowers its perceived value, and this impacts grass pea research competitiveness. Improving the externally perceived value of grass pea could influence greater investment in its improvement. Stories should raise attention of grass pea's potential in wider climate-smart and resilience research. These messages should be released routinely over established social media channels and general research news.

Positioning for investment

There is a need to develop a funding strategy for further grass pea development. Recent donor activity shows interest in underutilised crops, locally adapted resilience and new resilience traits for breeding into other crops. Grass pea offers potential across these dimensions and adds good nutritional qualities at a low input cost. Combining these components could create an attractive breeding pipeline.

A first step towards funding a large grass pea breeding initiative might be to visibly increase cohesion and strategy between research programmes. A recent funding development is grass pea's inclusion on the $58 million BOLD (Biodiversity for Opportunities, Livelihoods and Development) project. BOLD specifically looks at seven crops, including grass pea. Grass pea will be supported until 2030 and the project is in the first of three phases. The multiple components of BOLD offer diverse areas for additional research to compliment and build on. BOLD might therefore provide the space for smaller add-on packets of grass pea research proposals. Complimenting projects like BOLD might be attractive to donors, require smaller investments, build cohesion efforts and return greater overall results.



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