Breeding for species mixtures: 50 Years, One Key Metric - Exporting Switzerland's Competitive-Ability Approach from Pasture to Arable Systems?

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Interview with Dr. Daniel Suter, Head of Forage Crop Variety Testing in Switzerland

For more than fifty years in Switzerland, varieties have undergone testing not only in monoculture but also in mixed stands, and thus provided a rare example of integrating crop associations in an official variety testing scheme. The primary objective is to gain insights into the competitive strength of the tested varieties. This information holds particular significance in the formulation of clover-grass mixtures, as over 90% of cultivated fields in Switzerland, dedicated to meadows and pastures, have traditionally been sown with clover-grass mixtures. This longstanding practice reflects the agricultural importance attached to understanding the interplay between different varieties in mixed cropping systems. In our interview with Dr. Daniel Suter, Head of Variety Testing for Forage Crops in Switzerland, we delve into the intricacies of forage crop variety testing and its implications for agricultural practices and breeding strategies. The purpose of this interview is to provide valuable information that might help to transfer this successful application of crop association cultivar testing to forage crop testing schemes in other countries and possibly extrapolate insights to other cultivation systems such as arable farming.

The interview occurred on 30 January 2024 and has been translated from German.

Selection of Mixture Partners

Dr. Pierre Hohmann (PH): Which and how many varieties are used as mixture partners in your variety testing trials? Are there designated testers (single or variety mixtures) or do you perform several combinations of varieties from involved species?

Dr. Daniel Suter (DS): Generally, any recommended variety could be used as a mixture partner, as they possess a known competitive ability reaching a certain minimum level. Typically, for consistency reasons, the same variety is used over several years. In each trial, only one variety is used as a mixture partner. Given the complexity of practical mixtures, testing every possible combination directly is impractical. Observations are made in very simple mixtures (binary to ternary), serving as indicators for the competitive strength of the tested variety. It is important to note that a forage plant species is utilised in various mixtures, making generic information about its competitive strength more relevant than observations from any specific complex mixture. In cases where forage plant species are later used in more defined mixture types, the partner can be selected from species characteristic of that particular mixture type.

PH: On what basis are the testers selected?

DS: The chosen tester must, as previously mentioned, exhibit high agronomic quality and strong competitive ability. The list of recommended varieties provides the necessary information in this regard.

Statistical approaches

PH: Do you consider any statistical approaches, such as incomplete factorial designs, to limit the number of combinations to be tested?

DS: Since there is only one combination per tested variety, experimental designs similar to pure stands are applicable. In Switzerland, latin rectangles with three rows/columns (occasionally two) are used, with the unit being a small plot of 6 x 1.5 metres.

Plant traits

PH: Are plant traits assessed (in mixture or pure stand) indicating suitability for mixture cultivation?

DS: The only parameter assessed in the mixture is the yield proportion of the tested variety in the mixture. In forage crops, the entire shoot above the cutting height contributes to the yield. Mixture suitability is primarily influenced by competitive strength. During the initial thirty years of competition testing, yield proportions were determined through botanical analyses. However, subsequent studies indicated that estimates of standing dry matter yield are equally precise. Therefore, yield proportions are mostly estimated and validated through botanical analyses. To incorporate observations into the assessment of a tested variety, the percentage yield proportion is converted into a rating (scale: 1 = good to 9 = poor) using the following formula: Rating = 9 - 0.08 x Yield Proportion (%). Additionally, information on early maturity (collected in specially designated pure stands) aids in selecting varieties suitable for specific mixtures.

Participation of Stakeholders

PH: Are decentralized/participatory activities considered, such as trials conducted by farmers and in collaborations with public institutions like Agroscope and universities?

DS: Experiments are exclusively conducted by Agroscope. While trials are consistently conducted on Agroscope-owned or leased land, occasional experiments may take place on private farms or on the premises of other public institutions. However, these are mostly locations with experiments in pure stands. Mixed crop experiments do not hold as prominent a position as pure stand trials. For example, there are five locations with pure stands in the Swiss Midlands (area between the Alps and Jura), while there are only four with mixed trials in the same region. Occasionally, an additional high-altitude location with mixed trials may be included.

Impact on Breeders

PH: Do you believe mixture testing provides incentives for forage breeders to include mixing ability in their breeding programmes?

DS: All variables considered in variety testing influence the establishment of breeding goals. Since clover and grass are typically used in mixtures in Switzerland, the selection of suitable mixtures is more critical for farmers than knowledge of individual varieties. The list of recommended varieties primarily provides seed merchants and other developers of mixture formulations (e.g., Agroscope) with the necessary information to choose the right varieties for creating the best mixtures. The list serves as a reference document for trade rather than practitioners. This distinguishes forage crops (grasses and forage legumes) significantly from other crops, where variety knowledge is central for practitioners. For the best forage plant varieties to be practically utilised, the Swiss standard mixture system mandates the use of recommended varieties. Similarly, the use of recommended varieties is a prerequisite for the quality label awarded by the Association for the Promotion of Forage Production (AGFF).

Other Success Factors

PH: In your view, are there other factors crucial for successful mixture testing? I'm thinking of communication tools, databases (or other digital solutions), subsidies, etc. How did it all begin 50 years ago?

DS: A crucial factor is likely simple agronomic reasoning, which should have a central role in establishing any regulatory framework. I am sceptical about the lasting effectiveness of subsidies; a system should be able to stand on its own. It is important that there are enough examples of practical applications benefiting from mixture testing. Unfortunately, I cannot comment on how adequate communication and efficient dissemination of results should look for crops other than forage plants. Our experience is limited to the publication of the "List of Recommended Varieties of Forage Plants" and the subsequent "Standard Mixtures for Forage Production" (https://www.agroscope.admin.ch/agroscope/en/home/news/newsroom/2025/01-28_Sortenliste-standardmischungen-futterbau.html).

The introduction of testing in mixed stands arose from the need to better describe and assess varieties in terms of their competitive strength, as these varieties are primarily used in mixtures.

Knowledge and Resources

PH: Is there a lack of knowledge or other resources needed to conduct or expand mixture testing (if desired at all)?

DS: I assume this question pertains to crops where mixture testing does not currently exist. Unfortunately, I feel somewhat ill-equipped to comment on this. However, I believe it is sufficient, for now, to take the initial step.

PH: Thank you very much for your time and valuable input.

Conclusion

The Swiss experience confirms that embedding mixture performance in national variety-testing protocols is both feasible and impactful. Decades of data show that a single, easily measured trait—yield proportion in mixed stands—captures the competitive ability breeders need, while streamlined Latin-rectangle designs keep the workload comparable to standard pure-stand trials. Combined with clear incentives, e.g. the mandatory use of recommended varieties in Swiss standard mixtures, this approach ensures that superior genotypes actually reach farmers' fields. The Swiss model offers a scalable template that other testing authorities can adopt: focus on a single, mixture-relevant metric, maintain continuity in tester varieties, and link official recommendations to market uptake. Doing so can help translate the documented benefits of legume–grass systems into real genetic progress without overstretching testing resources.

For more information related the EU CAP Network Focus Group on crop associations, including a dedicated mini paper on "Cultivar testing as a key to boost uptake of crop associations in breeding and farming", check out: https://eu-cap-network.ec.europa.eu/focus-group-crop-associations-including-milpa-and-protein-crops_en

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