*Comment on Smaje, C. ‘The strong perennial vision’ by Doug Cattani, perennial grain breeder at the University of Manitoba*

I have just read your paper on SPV and would like to comment on it.

Your understanding that to markedly enhance the sexually reproductive nature of perennials will have impacts on perenniality I think is accurate. As in annual species, we see year to year variation in yields (as I hope is known).  Selection can be made within the population to move sexual reproduction from a low level (1-10%) to maybe 20% (Harvest Index). If we can have a stable allocation %, one which does not change greatly as the plant ages, as it seems to, then perennial grains should have a role to play in reducing the impact of agriculture. Based upon my experience with herbaceous perennial seed production (forage seed) I feel that to have a truly sustainable form of perennial productivity, in my opinion, we will have to go to a polyculture where our overall productivity of one crop is reduced however we have numerous crops that can be potentially harvested. I also see animal and maybe other foodstuffs (i.e. honey) being produced from these cropping polycultures. A given in this is the development of perennial grains, oilseeds, fibre products, etc..  Initially, this will be most suited to lands that suffer production limitations. For example, where I am located, agricultural land where spring flooding hampers seeding, sometimes to the point to no crop being sown, perennials, once established, would have the capacity to persist through the flooded conditions and regrow once the stress has passed.

Monoculture in perennials is not a given as not all grow throughout the “growing season”, or have different portions of the growing season in which the actively are productive. To be reproductive (sexually), however, many require adequate growth prior to the onset of winter (for lack of a better term) for vernalization to take place. Similar to winter wheat, without this pre-winter growth, reproductive output (seed production) the following year would be non-existent. This may be another factor in choosing annuals over perennials. Post seed harvest renovation is required for many perennial seed crops, especially those that have dual induction mechanisms for reproductive (sexual) growth. Therefore seed yield potential is set prior to the growing season of production in these species. These species also consolidate resources for the next seasons growth, although not all are recycled within the plant. During season impacts on plant development affect the realization of seed yield (although seed yield component compensation can allow for some increase in seed productivity during the growing season). Nutrient levels, say at a 20% harvest index will probably be quite lower than for an annual crop ( I am basing this on experience with perennial seed production, although this is not always the case, e.g. perennial ryegrass response to  increasing nitrogen). The inclusion of grazing on these lands would supply some nutrients, and the benefit of at least short-term C sequestration, would allow perennial grain production to potentially maintain the status quo in rotations with annual crops.

Other factors not specifically including in your work (although they are probably implied) are that the yield will be relatively stable across years. As I have I hope previously pointed out that we will need to put the crop in the best way for seed yield potential maximization, therefore agronomic work is greatly required.  I am currently finishing up a manuscript on seed yield stability (relative yield stability) in intermediate wheatgrass that has shown that seed yield across years is a difficult thing to predict on an individual basis and that there is a great deal of diversity within the population. Selection of highly reproductive allocating individuals need to be tested in field environments (row planted).  These will provide some inkling of what selection is likely to produce.

Selection for seed size will increase seedling competitiveness, not necessarily to a ruderal status, but enough to allow for a reasonable expectation of establishment. Increasing seed size reduces % protein in the seed, although it is currently in the 20% range. Selection for a reduced rhizomatous nature, possibly via selecting for reduced internode length may help with allocation to reproductive versus vegetative growth. This will change the CSR ranking of the individual, but I think we already can show examples of differential CSR rankings within species.

As noted above, one other factor is that perennials do sequester storage energy for not only overwintering (where I am growing these, we have up to 6 months of non-growth) but also regrowth in the spring. If storage can be increased from regrowth after harvest (perhaps through agronomic manipulation), this can provide additional energy for reproductive growth and potentially increasing Harvest Index in the following growing season. These will not be quick gains. Canola (rapeseed) has taken 60 or so years to increase it yields to the current levels experienced in Manitoba (approximately 3 x the yield levels of 1960). Investment in breeding and agronomy have led to this result. Similar investments are necessary to move perennial grains forward although some easy gains will be made initially (e.g. selection for seed size, selection for adaptation to growth environments) enhancing the yield potential.

In conclusion, I agree that SPV is probably not where perennial grains will reach, at least not in the foreseeable future. As indicated by Bell and his co-workers, initial acceptance will come from dual use and on marginal lands. Potential is there, although to what extent, for a perennial grain (or oilseed), maybe even an SPV. I currently do not foresee a long lived (although I currently foresee 4-5 years of consistent seed harvests), especially as a monoculture given our current agronomic understanding of the crop. A perennial grain crop of this duration will aid agriculture in general.