Risk analysis of selecting hybrids in irrigated maize production

Orsolya NAGY – Fruzsina NAGY – János NAGY

University of Debrecen, Institute for Land Utilisation, Regional Development and Technology,
E-mail: orsolyanagy.dr@gmail.com; nagy.fruzsina@agr.unideb.hu; nagyjanos@agr.unideb.hu

Keywords: maize hybrids, irrigation, risk analysis

Introduction

Based on the polyfactorial experiment with randomised design and four replications performed at the Research Centre of the University of Debrecen, the effect of various methods as a factor affecting maize production was examined (*Nagy*, 2006, 2012). It is especially important to examine various maize hybrids used in different territorial proportions from the aspect of when exactly each of them provides the given yield level at the lowest level of risk. The applied analytical methods were stochastic dominance and expected value – variance risk programming criteria (*Drimba-Nagy*, 1997).

Farmers face various decision-making challenges when reaching their goals (*Chavas, Posner & Hedtcke*, 2009). Several researchers used risk assessment mean-variance / mean-standard deviation analyses and stochastic dominance approaches, for example in relation to risk avoidance behaviour, the utility functions of farmers and the cumulative distribution functions of return (e.g. *Hadar & Russell*, 1969; *Hanoch & Levy*, 1969).

Materials and methods

The reliability of research is guaranteed by the Polyfactorial Long-term Field Experiments – *variety* x *fertilisation* x *crop density* x *tillage* x *irrigation* – established at the Univ. of Debrecen. The natural nutrient conversion rate of the new examined hybrids can be accurately determined based on the results of the 30-year-old non-fertilised control plots. This unique experiment performs a time series analysis of the efficiency of water replenishment in the irrigated treatment of the whole polyfactorial long-term field experiment with four replications. The applied analytical methods were *stochastic dominance (SD) risk programming model and expected value – variance (E-V) risk programming model.*

Results and discussion

In conformity with our previous research, the examined hybrids were compared to each other based on their yields. The performed research included the evaluation of the yield frequencies of hybrids *H1, H2 and H3* under irrigated conditions. Based on the obtained findings, it was concluded that the frequency of yields above 11 t ha^{-1} of hybrids *H1* and *H2* is above 80, while the most frequently (60) observed yields of the hybrid *H3* is between 12 and 13 t ha^{-1}. Based on the analysis of primary *SD* curves, it was concluded that the hybrid *H3* dominates both varieties in the yield range of 9-14 t ha^{-1}. Within the same range, the hybrid *H1* has a higher probability to take up these values, in comparison with *H2*. Based on the secondary *SD* criterion, the hybrid *H3* dominates *H1* and *H2* above 10 t ha^{-1}. Using the risk programming model, it was concluded that, under irrigated conditions, the given yield level can be achieved at the lowest risk by using the hybrid *H2* to a higher extent in

 doi: 10.34116/NTI.2019.AA.52

the case of lower yields (9.4-9.7 t ha^{-1}) under irrigated conditions, while the same refers to *H3* at higher yield levels (9.8-10.2 t ha^{-1}).A yield level of 9.4 t ha^{-1} can be achieved at the lowest risk. The hybrid *H2* contributes 85% to this value, while *H1* and *H3* contribute 7-7 %, respectively.

Table 1: Hybrid proportions (%) needed to obtain yields (E, t ha^{-1}) of the lowest risk (V_{min} t^2/ha^2) (%) in irrigated treatment

E	H1	H2	H3	V_{min}
9.4	7.35 %	85.49 %	7.16 %	5.486
9.6	16.29 %	57.97 %	25.73 %	5.975
9.8	25.23 %	30.45 %	44.31 %	6.722
10	34.18 %	2.94 %	62.89 %	7.726
10.2	4.17%	0.00 %	95.83 %	9.122

Based on the obtained research findings, it was concluded that, if the decision-maker is willing to plan a lower yield level instead of a high one, this decision results in decreased risk. For example, if the decision-maker chooses a lower yield (9.8 t ha^{-1}) instead of 10.2 t ha^{-1}, a 5.1% decrease in expected yield (*E*) results in a 26.3% reduction of the variance expressing risk.

Conclusions

It was shown that if farmers are willing to settle with slightly lower yields instead of the highest yields, the sacrifice made with lower yields will be made up for by a significantly higher proportion of risk reduction. This statement has been confirmed by *Ngwira et al.* (2013) too, who evinced that sustainably higher maize yield can be obtained at lower input cost levels.

Acknowledgement

The research was financed by the Higher Education Institutional Excellence Programme of the Ministry of Human Capacities in Hungary, within the framework of the 4.thematic programme of the University of Debrecen, and the projects "GINOP-2.2.1-15-2016-00001 - Developing a scale-independent complex precision consultancy system" and "EFOP-3.6.3-VEKOP-16-2017-00008".

References

Chavas, J.P.– Posner, J.L.–Hedtcke, J.L. (2009): Organic and conventional production systems in the Wisconsin Integrated Cropping Systems Trial: II. Economic & Risk Analysis 1993-2006. Agronomy Journal. 101. 2: 288-295. https://doi.org/10.2134/agronj2008.0055x

Drimba, P.– Nagy, J. (1997): Kukoricahibridekkel végzett kockázatvizsgálat eredményei. Növénytermelés 46. 5.: 487-498.

Hadar, J.– William, R.R. (1969): Rules for ordering uncertain prospects. The American Economic Review. 59. 1: 25-34.

Hanoch, G.– Levy, H. (1969): The Efficiency Analysis of Choices Involving Risk. Review of Economic Studies, 36. 3: 335-346. https://doi.org/10.2307/2296431

Nagy, J.: (2006): Maize production. Akadémiai Kiadó. Budapest

Nagy, J.: (2012): The effect of fertilization and precipitation on the yield of maize (*Zea mays* L.) in a long-term experiment. Időjárás. 116. 1: 39-52.

Ngwira, A.R., Thierfelder, C., Eash, N., Lambert, D.M.: (2013): Risk and maize-based cropping systems for Smallholder Malawi farmers using Conservation agriculture technologies. Cambridge Univ. Press. 49. 4: 483-503. https://doi.org/10.1017/s0014479713000306

doi: 10.34116/NTI.2019.AA.52