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# EVALUATION OF THE AVERAGE AGE OF VEGETABLE VARIETIES AS THE MEASURE OF VARIETAL REPLACEMENT ON THE POLISH MARKET IN THE YEARS 1988-2000

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## ABSTRACT

The analysis of the average age of varieties was carried out for 1535 varieties ascribed to 56 taxa and owned by both Polish and foreign breeders in the years 1988-2000. A vegetable variety was ca. 9 years old on average. For particular crops the value ranged from 1 for stem lettuce to 30 years for garden sorrel and turnip.

**Key words:** vegetable, average age, life cycle

## INTRODUCTION

Factors influencing the life cycle of a plant variety can be classified into two groups: internal factors coming from the company itself and external factors coming from the market. Breeders are interested in having good varieties lasting on the market for a very long time and guaranteeing continuous profits. Growers, on the other hand, also need some time to learn to grow a given variety in the best possible way. The same can be stated for consumers needing time to accept new vegetable varieties. Nevertheless, a constant flow of new varieties is required to provide growers with better sets of characteristics that can improve productivity and/or quality of their products and adjust the production to the changing requirements of end-users, i.e. fresh market, canning

industry, supermarkets, etc. Modified requirements of vegetable users find also reflection in changing criteria for adding varieties to recommended lists [11]. Balancing the willingness of receiving adequate return and having competitive position on the marketplace, seed companies are interested in selling their varieties for at least a few years. Managing the variety life cycle is one of the most important decisions in a seed company. As for other products in the life cycle of a plant variety several phases can be distinguished (development, introduction, growth, maturity and decline) and different marketing strategies should be used in each phase [8]. Analysing the lengths of varieties' life cycles and the rate of varietal replacement can help in preparation and implementation of marketing strategies through monitoring the market situation and tracking varieties as well as provide information on the effectiveness of breeding programmes. Brennan and Byerlee [5] considered the rate of crop varietal replacement as an important tool that could be used by plant breeders, plant pathologists and policy makers.

The paper aimed at evaluation of the Polish market for particular vegetables using the length of varieties' life cycle and average age of a single variety as the measures of the rate of varietal replacement. The results of the analysis were expected to provide an insight into dynamics of vegetable varieties' market.

## MATERIALS AND METHODS

National "Lists of Vegetable Cultivars" (NLs) published by the Research Centre for Cultivar Testing in Słupia Wielka were used as the sources of data on vegetable varieties admitted to marketing in Poland from 1988 to 2000 [1]. The varieties were grouped in 56 taxa. Because of the economic importance and different uses within the limits of tomato and cucumber varieties cultivated under protection and in open field were distinguished and referred as separate taxa.

To evaluate varieties' life cycles, the following sources of information were exploited: NLs, product catalogues, seed and breeding companies and centres involved in variety testing. The techniques used for gathering information covered [8, 10] desk research and interviews (personal interviews, postal surveys and telephone interviews).

The average age ($A_{AV}$) of a single variety and the average age ($A_{AY}$) in subsequent years were computed on the basis of varieties' life cycles as follows:

$$A_{AV} = \frac{\sum_{it=1}^{n} A_{it}}{n},$$

$$A_{AY} = \frac{\sum_{i=1}^{n_t} A_{it}}{n_t}$$

where:
$A_{it}$ – age of a variety $i$ in a year $t$,
$n$ – number of combinations of varieties $i$ and years $t$,
$n_t$ – number of varieties in a year $t$.

Average age was calculated for particular vegetable taxa. It indicated the rate of varietal replacement for each crop.

Changes of the average age of varieties within a vegetable taxon in the years 1988-2000 were described by linear regression equations: $y = bx + a$. Regression coefficient $b$ expressed the annual changes of the average age of varieties on the Polish market. Coefficient of determination ($R^2$) was computed for each linear regression equation. Significance of the difference of coefficient $b$ from zero was estimated according to F test at $p = 0.05$, 0.01 and 0.001 using the statistical package Minitab [9].

## RESULTS AND DISCUSSION

The lengths of 1535 varieties' life cycle being on the NLs were evaluated for the period of 1988-2000. 776 foreign vegetable varieties (previously marketed abroad) and 435 Polish ones entered the "List of Vegetable Cultivars" in Poland in 1988-2000 [6]. In the thirteen years analysed two sub-periods could be distinguished: the

years 1988-1990 of restricted inflow of foreign varieties (foreign varieties were listed at the requests of Polish centres) and the years 1991-2000 of market economy. The lengths of life cycles of the above-mentioned 1535 varieties ranged from 0 to 46 years (table 1). 1223 (almost 80%) of the total number of varieties were still marketed, i.e. sold or offered for selling, in the year 2000. For about 51% of the varieties the lengths of their life cycle varied between 1 and 5 years, for 78% – between 1 and 10 years, for 86% – 1 and 15 years and for over 90% of the varieties did not exceeded 20 years. The longest life on the market of 46 years was noted for 30 varieties (2% of the total number of varieties included in the analysis), for all of which the life cycles were pending. Polish varieties comprised only 31% of the total number of varieties being on the market for 1-10 years and 73% of the varieties marketed for over 10 years (table 1). According to Duczmal and Braun-Młodecka Polish varieties were marketed for almost 13 years on average and foreign ones for less than 5 years [7]. There were a few reasons of the long presence of some varieties on the market. Polish seed companies owned a marked number of selected varieties, i.e. old, unprotected varieties bred abroad and maintained by Polish centres. The maintenance of such varieties was the easiest way to widen the assortment of some companies. Moreover, the subsidies for Polish breeders depended on the number of varieties listed. Furthermore, the Polish seed companies sold approximately 70-80% of their seeds to growers preferring well-known varieties to new ones. Finally, the high value of some varieties justified their long market life. In a few cases, varieties' presence on the Polish market was longer than allowed by the Seed Act, i.e. more than three years after the removal from the NL [3]. Silvey [11] showed that about 10% of the total number of varieties of winter wheat recommended in the UK over the years 1955-1996 had atypically long periods of recommendation. However, the period mentioned by Silvey [11] varied from 17 to 24 years.

**Table 1. Numbers of varieties according to the lengths of their life cycle in the years 1988-2000**

| Lengths of varieties' life cycle (years) | Numbers of varieties on the market | | | | | |
|---|---|---|---|---|---|---|
| | in the years 1988-2000 | | | of which in the year 2000 | | |
| | **Total** | Polish | Foreign | **Total** | Polish | Foreign |
| 0 | **10** | 8 | 2 | **-** | - | - |
| 1-5 | **789** | 214 | 548 + 27* | **695** | 230 | 465 |
| 6-10 | **412** | 159 | 225 + 28 | **315** | 133 | 182 |
| 11-15 | **122** | 85 | 26 + 11 | **71** | 56 | 15 |
| 16-20 | **64** | 35 | 16 + 13 | **38** | 26 | 12 |
| 21-25 | **38** | 33 | 3 + 2 | **25** | 23 | 2 |
| 26-30 | **40** | 27 | - + 13 | **27** | 27 | - |
| 31-35 | **12** | 8 | 4 | **9** | 9 | - |
| 36-40 | **12** | 12 | - | **10** | 10 | - |
| 41-45 | **6** | 6 | - | **3** | 3 | - |
| 46 | **30** | 30 | - | **30** | 30 | - |
| **Total** | **1535** | **617** | **918 + 94** | **1223** | **547** | **676** |

*numbers of foreign varieties listed at the requests of Polish centres in 1988-1990

Taking into account all the taxa, the average age of a single variety was ca. 9 years. For particular vegetables (excluding mushroom) the value ranged from 1 year for stem lettuce to 30 years for garden sorrel and turnip (table 2).

The vegetables could be classified into three groups:

- taxa, for which an increase of the average age significantly different from zero according to F test was noted, i.e. vegetables of declining rate of varietal replacement (eggplant, garden dill, garden sorrel, garlic, horse radish, leaf lettuce, rhubarb, popcorn, pumpkin (summer squash) swede, tomato – cherry type, tomato – varieties cultivated under protection and turnip);
- taxa, for which the changes of the coefficient *b* were not significantly different from zero, i.e. the rate of varietal exchange was stable or the analysis covered too short period. These were: stem lettuce, black radish, black salsify, Brussels sprouts, cauliflower, celeriac, celery, chickling vetch, Chinese cabbage, cos lettuce, curly kale, French bean – dwarf, garden pea, kohlrabi, leek, lentil, melon, parsley, pepper, red garden beet, runner bean, spinach, sprouting broccoli, sweet fennel, sweet maize and watermelon;

- taxa, for which a decrease of the average age was noted, i.e. vegetables of increasing rate of varietal replacement (asparagus, broad bean, carrot, cucumber – varieties cultivated in open field, cucumber – varieties cultivated under protection, French bean – climbing, head lettuce, onion, pumpkin (winter squash), radish, red cabbage, salad chicory, savoy cabbage, tomato – varieties cultivated in open field, turnip-rooted parsley and white cabbage).

Cabbage, carrot, onion, red garden beet, cucumber and tomato cultivated in open field dominated the vegetable production in Poland in 1999 [2]. For the six most important vegetables in Poland, except for red garden beet, the rate of varietal replacement tended to increase and the regression coefficient *b* for the taxa varied between –0,11 for white cabbage and –0,72 for carrot. Most of the varieties of white cabbage, carrot and onion listed in the years 1988-2000 belonged to the Dutch company Bejo Zaden B.V. and the increasing rate of varietal replacement for the crops was mainly caused by larger and larger interest of the company in Polish seed market [4].

**Table 2. Average age of vegetable varieties on the market from 1988 to 2000**

| Taxon | Average age of a single variety (years) | Changes in the average age in years | |
|---|---|---|---|
| | | *b* | $R^2$ |
| Asparagus (*Asparagus officinalis* L.) | 9.2 | - 0.80* | 0.35 |
| Black radish (*Raphanus sativus* L. *var. niger* (Mill.) S. Kemer) | 26.3 | -0.08 | 0.02 |
| Black salsify (*Tragopogon porrifolius* L.) | 14.4 | 0.35 | 0.26 |
| Broad bean (*Vicia faba* L. *var. major* Harz) | 11.9 | -1.17*** | 0.67 |
| Brussels sprouts (*Brassica oleracea* L. *ssp. oleracea convar. fructicosa* (Metzg.) Alef. *var. gemmifera* DC.) | 8.2 | 0.03 | 0.03 |
| Carrot (*Daucus carota* L. *ssp. sativus* (Hoffm.) Schlubl et G. Martens) | 11.3 | -0.72*** | 0.73 |
| Cauliflower (*Brassica oleracea* L. *ssp. oleracea convar. botrytis* (L.) Alef. *var. botrytis*) | 6.1 | -0.08 | 0.13 |
| Celeriac (*Apium graveolens* L. *var. rapaceum* (Mill.) Gaud.) | 11.0 | -0.30 | 0.16 |
| Celery (*Apium graveolens* L. *var dulce* (Mill.) Pers.) | 1.3 | - | - |
| Chickling vetch (*Lathyrus sativus* L.) | 2.0 | 1.00 | - |
| Chinese cabbage (*Brassica rapa* L. emend. Metzg. *ssp. pekinensis* (Lour.) Hanelt.) | 1.5 | - | - |
| Cos lettuce (*Lactuca sativa* L. *var. longifolia* Lam.) | 1.5 | 1.00 | 1.00 |
| Cucumber – varieties cultivated in open field (*Cucumis sativus* L.) | 9.2 | -0.21*** | 0.71 |
| Cucumber – varieties cultivated under protection (*Cucumis sativus* L.) | 6.0 | -0.53** | 0.58 |
| Curly kale (*Brassica oleracea* L. *ssp. oleracea convar. acephala* (DC.) Alef.*var. sabellica* L.) | 19.2 | -0.06 | 0.00 |
| Eggplant (*Solanum melongena* L.) | 15.0 | 1.00*** | 1.00 |
| French bean – dwarf (*Phaseolus vulgaris* L. *var. nanus* (L.) Aschers.) | 9.9 | -0.07 | 0.10 |
| French bean – climbing (*Phaseolus vulgaris* L. *var. vulgaris*) | 8.4 | -0.68** | 0.64 |
| Garden dill (*Anethum graveolens* L.) | 4.6 | 0.40* | 0.41 |
| Garden pea (*Pisum sativum* L.) | 11.5 | -0.03 | 0.06 |
| Garden sorrel (*Rumex acetosa* L.) | 30.0 | 1.00*** | 1.00 |
| Garlic (*Allium sativum* L.) | 2.9 | 0.49*** | 0.91 |
| Head lettuce (*Lactuca sativa* L. *var. capitata* L.) | 9.1 | -0.52*** | 0.83 |
| Horse radish (*Armoracia rusticana* Gaertn.) | 9.0 | 1.00*** | 1.00 |
| Kohlrabi (*Brassica oleracea* L. *ssp. oleracea convar. caulocarpa* (DC.) Alef. *var. gongylodes* L.) | 17.1 | -0.18 | 0.12 |
| Leaf lettuce (*Lactuca sativa* L. *var. crispa* L.) | 3.0 | 0.62*** | 0.95 |
| Leek (*Allium porrum* L.) | 5.7 | -0.48 | 0.26 |
| Lentil (*Lens culinaris* Medik.) | 1.7 | 0.67 | 0.92 |
| Melon (*Cucumis melo* L.) | 5.5 | -0.25 | 0.08 |
| Mushroom (*Agaricus bisporus* (Lange) Sing.) | - | - | - |
| Onion (*Allium cepa* L.) | 9.2 | -0.56*** | 0.74 |
| Parsley (*Petroselinum crispum* (Mill.) Nym. Ex A.W. Hill.*convar. crispum*) | 1.4 | - | - |

**Table 2 cont.**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Pepper (*Capsicum annuum* L.) | 5.4 | -0.03 | 0.03 |
| Popcorn (*Zea mays* L. *convar. microsperma* Koern.) | 5.7 | 1; 0.70***[1] | -; 0.94 |
| Pumpkin – summer squash (*Cucurbita pepo* L.) | 5.0 | 0.31*** | 0.76 |
| Pumpkin – winter squash (*Cucurbita maxima* Duch.) | 12.4 | -0.40* | 0.45 |
| Radish (*Raphanus sativus* L. *var. sativus*) | 14.5 | -0.46** | 0.60 |
| Red cabbage (*Brassica oleracea* L. *ssp. oleracea convar. capitata* (L.) Alef. *var. capitata* L. *f. rubra* DC.) | 10.3 | -0.44** | 0.53 |
| Red garden beet (*Beta vulgaris* L. *ssp. vulgaris convar. vulgaris var. vulgaris*) | 15.6 | -0.66 | 0.11 |
| Rhubarb (*Rheum rhabarbarum* L.) | 25.1 | 0.64*** | 0.67 |
| Runner bean (*Phaseolus coccineus* L.) | 8.5 | -0.27 | 0.30 |
| Salad chicory (*Cichorium intybus* L. *var. foliosum* Hegi) | 4.0 | -0.09** | 0.51 |
| Savoy cabbage (*Brassica oleracea* L. *ssp. oleracea convar. capitata* (L.) Alef. *var. sabauda* L.) | 6.3 | -0.28* | 0.41 |
| Spinach (*Spinacia oleracea* L.) | 9.6 | 0.00 | 0.00 |
| Sprouting broccoli (*Brassica oleracea* L. *ssp. oleracea convar. botrytis* (L.) Alef. *var. italica* Plenck) | 6.9 | -0.11 | 0.09 |
| Stem lettuce (*Lactuca sativa* L. *var. angustana hort.* ex L. H. Bailey) | 1.0 | - | - |
| Swede (*Brassica napus* L. emend. Metzg. *ssp. rapifera* Metzg.) | 29.0 | 1.00*** | 1.00 |
| Sweet fennel (*Foeniculus vulgare* Mill. *ssp. vulgare var. azoricum* (Mill.) Thell.) | 1.5 | - | - |
| Sweet maize (*Zea mays* L. *convar. saccharata* Koern.) | 10.0 | 0.02 | 0.00 |
| Tomato – cherry type (*Lycopersicon esculentum* Mill. *nom. cons. var. cerasiforme* (Dun.) A. Gray) | 3.5 | 0.51*** | 0.92 |
| Tomato – varieties cultivated in open field (*Lycopersicon esculentum* Mill. *nom. cons. var. esculentum*) | 9.1 | -0.48*** | 0.90 |
| Tomato – varieties cultivated under protection (*Lycopersicon esculentum* Mill. *nom. cons. var. esculentum*) | 5.3 | 0.08* | 0.31 |
| Turnip (*Brassica rapa* L. *var. rapifera* Metzger) | 30.0 | 1.00*** | 1.00 |
| Turnip-rooted parsley (*Petroselinum crispum* (Mill.) Nym. ex A. W. Hill. *convar. radicosum* (Alef.) Danert. | 25.9 | -1.82*** | 0.76 |
| Watermelon (*Citrullus lanatus* Matsum. et Nakai *ssp. vulgaris* Fursa *var. vulgaris*) | 1.8 | 0.75 | 0.96 |
| White cabbage (*Brassica oleracea* L. *ssp. oleracea convar. capitata* (L.) Alef. *var. capitata* L. *f. alba* DC.) | 9.8 | -0.11*** | 0.87 |
| **Total** | **9.1** | **0.36*** ** | **0.80** |

Explanations:
b – coefficient of linear regression: $y = bx + a$,
$R^2$ – coefficient of determination,
*coefficient *b* significantly different from zero at $p \leq 0,05$ according to F test,
**coefficient *b* significantly different from zero at $p \leq 0,01$ according to F test,
***coefficient *b* significantly different from zero at $p \leq 0,05$ according to F test,
1 – for popcorn linear regression equations were calculated for two periods: 1988-1993 and 1996-2000.

## CONCLUSIONS

1. The lengths of 1535 varieties life cycles being on the NLs in the thirteen-year period of 1988-2000 ranged from 0 to 46 years.
2. The average age of a single variety was about nine years and ranged between 1 and 30 for particular crops.
3. For the most important vegetables in Poland except for red garden beet the rate of varietal replacement increased in the period analysed.

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