Differentiation of variable costs in the Austrian agricultural production

Differenzierung variabler Kosten in der Agrarproduktion Österreichs

Karin HEINSCHINK, Franz SINABELL and Christoph TRIBL

Summary

This paper presents INCAP ('Index-based Costs of Agricultural Production'), a detailed data set on production costs in the Austrian agriculture. The work is based on existing detailed data repositories. Its contribution to the knowledge base is to explicitly represent management variants and time. The aim is to capture the heterogeneity of agricultural production in Austria and the production costs of typical farms. Intended fields of application are farm and sector modelling and extension services.

Keywords: agricultural production costs; economic modelling; Austria

Zusammenfassung

Diese Arbeit präsentiert INCAP (‚Index-based Costs of Agricultural Production'), einen umfangreichen Datensatz über Produktionskosten in der österreichischen Landwirtschaft. Der vorgestellte Datensatz baut auf vorhandenen detaillierten Datenbeständen auf und bildet darüber hinaus die Dimensionen Management und Zeit explizit ab. Ziel ist es, die Heterogenität der österreichischen Agrarproduktion und die Kosten typischer Betriebe darzustellen. Das geplante Einsatzfeld sind quantitative Modelle und die landwirtschaftliche Betriebsberatung.

Schlagworte: Kosten in der Agrarproduktion, ökonomische Modellierung, Österreich

Erschienen im *Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie*, Band 25: 231-240, Jahr 2016. On-line verfügbar: http://oega.boku.ac.at.

1. Introduction

In any quantitative research task, it is vital to work with data adequate for answering the research question. The suitability of data depends on aspects such as availability/completeness, accessibility (publicly accessible or confidential), quality (e.g. historical or projected data, preliminary or final, exact match or proxy, representativeness, level of aggregation, plausibility/validity, accuracy), consistency (e.g. methodcal changes in time series), transparency (of sources and approach used), processibility, costs involved (in sourcing, processing, analysing data) etc.

Production costs are an essential element in most economic models of agriculture. Some models estimate them assuming specific technologies and/or functional forms using observed data. Others, such as linear programming (LP) or positive mathematical programming (PMP) models, use average production costs which are often based on gross margin (GM) calculations developed for extension services. This is also true for the Positive Agricultural and Forestry Sector Model of Austria (PASMA), a spatially-explicit economic land use model which identifies the GM-maximising activity mix in a given region (see e.g. SCHMID and SINABELL, 2006). Such models require comprehensive and detailed cost data which are usually available for the past but rarely for scenarios that make projections into the future. To overcome this gap, a new data set called *'Index-based Costs of Agricultural Production' (INCAP)* has been developed. INCAP accounts not only for a wide variety of activities relevant in the Austrian agriculture (e.g. production of quality wheat) combined with specific attributes (e.g. certain management variants), but it is also established as a time series from 2005 to 2050. With its focus on the micro-economic level, costs are specified per unit of output.

In this paper, INCAP and its structure are introduced (chapter 2.1), followed by a brief discussion of existing sources on cost-related data of the Austrian agricultural sector (chapter 2.2). The example of wheat is used to demonstrate the new database INCAP (chapter 3). The paper concludes with a summary, discussion and an outlook (chapter 4).

2. Approach and materials

Agro-economic models require technical (e.g. input quantities, yields, technology used) and economic information (e.g. input and output prices, agricultural payments). The respective data and literature are made available by numerous organisations, including public agencies, research institutes, interest groups and non-profit organisations. When developing a new data set, it is often more practical and cost-efficient to adapt existing data to the research task than to start from scratch. As for INCAP, dimensions were added to existing information and developed further, in particular management variants and time.

The development process was structured as such: (a) definition of INCAP's scope and structure; (b) exploration of existing data sets for relevance for and compatibility with INCAP; (c) selection of existing data sets and fitting them into INCAP's structure; (d) identification of alternative sources in case of missing data; (e) replacement of explicit data by functions[1] whenever possible to allow swift updates. In order to improve its reliability, INCAP is (f) subject to a series of checks and sensitivity analyses, (g) validated against other sources and scrutinised by experts and – if necessary – (h) revised to improve data quality and thus the quality of model results based on these data.

2.1 The structure of INCAP

Production activities in INCAP comprise three dimensions: (a) attributes, such as management variants, that aim at differentiating costs by activity, (b) cost items and (c) time. Regions are *not* an INCAP dimension. For spatially-explicit analyses, site- and region-specific characteristics (i.e. INCAP attributes) need to be assigned separately.

Due to differing attributes and cost items, INCAP is divided into plant (*INCAP.p*) and livestock (*INCAP.l*) production activities. INCAP.p contains all relevant crops (arable crops, feed, permanent crops), forage

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[1] For example, the amount of straw recovered is adjusted automatically when crop yield is altered. This is due to a function using corn-straw ratio and straw recovery rate. The corn-straw ratio of wheat is 1:0.8, the straw recovery rate is 0.8, hence wheat yield (in tonnes) x 0.8 x 0.8 equals straw recovered (in tonnes).

(silage, hay, grazing), fruit and vegetables. The activities represented in INCAP.l include meat, milk, eggs, wool and breeding animals.

Attributes and management variants

To reflect heterogeneity in production conditions and in the cost structure, the numeric level of certain cost items is differentiated by attributes that belong to certain attribute groups. For instance, the attribute group 'farming system' consists of the attributes 'conventional' and 'organic'. Some attribute groups are applicable to both INCAP.p and INCAP.l (e.g. farming system), whereas others are specific to plant activities (e.g. tillage system).

In INCAP.p, the attribute groups (and attributes) represented include field size (number of hectares, continuously adjustable), farming system (conventional; organic), tillage system (standard; conservation), labour type (own labour only; own and hired labour), climate (dry; humid) and plant protection intensity (high; medium; low). The resulting degree of differentiation is noteworthy: For instance, combining 30 plant production activities with the attributes mentioned (two different field sizes, two farming systems, two tillage systems, two labour types, two climate types, three plant protection intensities) gives 2,880 unique combinations in a single period. At present, some activity-attribute-combinations are technically or economically not meaningful (e.g. the activity 'hybrid maize' combined with the attribute 'organic farming' or the combination 'spelt, conventional farming') and are meanwhile removed from INCAP. Activities are moreover linked to certain land types (arable land; permanent cropland; permanent grassland). For example, the activity 'quality wheat' is assigned to the land type 'arable land', as it can only be produced on arable land.

In spatially-explicit analyses (e.g. carried out in PASMA), activities are constrained to geographic areas with suitable production conditions (specified at e.g. NUTS 3 level or even at a 1x1 km^2 grid). Production options may change over time or depending on a given scenario, and INCAP can be used for such scenario analyses. For instance, grape cultivation is limited to the eastern part of Austria in the baseline scenario. In a climate change scenario, the spatial constraint may be relaxed to allow grape cultivation in other parts of the country as well.

Cost items

Similar to the attribute groups, the cost items considered for plant and animal activities differ from one another. INCAP.p accounts for variable costs of seeds/propagating material, fertiliser, plant protection, machinery, insurance against natural hazards and other (e.g. cleaning, drying, storage). In INCAP.l, specific cost items include stock replacement, feed and veterinary services.

Time

The baseline data set is established for the reference period, i.e. the annual average 2011-2013. To generate data for specific years, price indices are applied to each cost item in the reference period. Currently, the indices stretch from the past (year 2005, e.g. agricultural price index) to the future (year 2050, e.g. OECD-FAO agricultural index).

2.2 Selection of information from existing data sets

A series of sources was reviewed with respect to their suitability for INCAP in terms of cost items, their differentiation by attributes and time reference. It must be emphasised that this section does not discuss their strengths or weaknesses per se, but rather identifies aspects which lead to a decision for or against their inclusion in INCAP.

GM calculations are available for Austria as 'Standard GM' (BMLFUW, 2008), 'Internet GM' (AWI, 2015a), 'Time Series GM' (AWI, 2015b) and 'GM based on Economic Accounts of Agriculture (EAA)' (SINABELL et al., 2011; STRAUSS et al., 2012). Further ones are developed in working groups ('Betriebszweigauswertung' BZA by BMLFUW, 2015) and by consultants in educational or extension services (e.g. rural education institute LFI, unpublished; Austrian Chamber of Agriculture LKÖ, unpublished). GM calculations for foreign countries are provided in the Bavarian version of 'Internet GM' (LFL BAYERN, 2015) or by international organisations (e.g. 'Dairy Report' by IFCN, 2015). *Bookkeeping data* are provided by the 'Farm Accountancy Data Network' (FADN) for Austria (e.g. LBG AUSTRIA, 2014; AWI, 2015c), all other EU countries (EC, 2015) and Switzerland (see e.g HOOP and SCHMID, 2015).

Of all sources reviewed, the 'Internet GM' data set was *chosen as the principal source for INCAP* since it meets most requirements: the information is Austria-specific and mostly based on published data (e.g. output prices, standard values for machinery costs; provided by public agencies), on functional relations (e.g. nutritional requirements for livestock), but also on unpublished data (e.g. input prices and typical input quantities; collected from suppliers). 'Internet GM' is updated periodically and publicly accessible through an online application, thus any user can individually revise INCAP by consistently referring to the principal source. The data set covers the majority of agricultural activities included in INCAP, thus entailing some consistency in the data generation across activities. These activities are differentiated in 'Internet GM' by attribute groups (e.g. farming system, labour input) and the cost structure is suitable for INCAP. 'Internet GM' is an information system in which almost any parameter can be adjusted to arbitrary farm situations and is therefore an important tool for farmers and agricultural extension services.

The other data sets mentioned above are *not considered as the principal source for INCAP* since they meet fewer requirements compared to 'Internet GM'. Some of those sources might, however, be used for validation and plausibility checks. The comprehensive 'Standard GM' data set accounts for most of the targeted activities and differentiates by several attribute groups but it dates back to 2007. The 'Time Series GM' calculations are only available for some livestock activities and the costs structure does not correspond to INCAP's. The 'EAA-based GM' data set is available as a time series (1995-2009) for a large number of activities, but lacks the differentiation by attributes (e.g. no distinction of farming systems), and the cost structure does not match INCAP's. The 'BZA' calculations, offering detailed data for numerous activities and periods, are based on records by the working groups' participants. Yet the 'BZA' data are not used for INCAP because the information is indicative of farms performing above average (rather than of typical farms) and because their use is restricted. The FADN results published for a time series for Austria are likewise based on observed data, however the methodology has been subject to substantial changes (e.g. the indicator 'standard GM' was replaced by the indicator 'standard output' in 2010). In addition, the FADN data are structured differently to INCAP's requirements regarding activities, attributes and cost items. Sources not specific to Austria, particularly the Bavarian 'Internet GM', may serve as a starting point where calculations for Austria are missing, but domestic data are given preference.

3. The example of wheat

INCAP includes the activity of quality wheat in 48 unique combinations. The variable costs depend on the attributes shown in table 1. Cleaning, storage and insurance costs are constant in each of the 48 combinations. Costs of seeds, fertiliser, plant protection and machinery differ due to farming type. Plant protection costs also vary based on protection intensity and climate. Machinery costs further depend on field size, tillage system and labour type. Due to this differentiation, total variable costs range from 505,-€/ha to 733,-€/ha (see figure 1).

Tab. 1: Range of variable costs for 48 combinations of quality wheat production, no straw recovery, field size: 2ha, tax excluded, in the baseline period (avg 2011-2013), €/ha

<table>
<tr><th>Cost item</th><th colspan="2">Differentiation by attribute group (attribute)</th><th>Min</th><th>Max</th></tr>
<tr><td>Seeds/propag. [a]</td><td>farming type</td><td>(Conventional, Organic)</td><td>75</td><td>98</td></tr>
<tr><td>Fertiliser</td><td>farming type</td><td>(Conventional, Organic)</td><td>191</td><td>199</td></tr>
<tr><td>Plant protection</td><td>farming type
climate type
PPI [e]</td><td>(Conventional, Organic)
(Dry, Humid)
(HighPPI, MedPPI, LowPPI)</td><td>0</td><td>142</td></tr>
<tr><td>Machinery [b]</td><td>farming type
field size
tillage system
labour type [f]</td><td>(Conventional, Organic)
(continuously adjustable)
(Standard, Conservation)
(OwnLab, HirLab)</td><td>176</td><td>320</td></tr>
<tr><td>Cleaning</td><td colspan="2">no</td><td colspan="2">0</td></tr>
<tr><td>Drying</td><td colspan="2">no [g]</td><td>9</td><td>15</td></tr>
<tr><td>Storage</td><td colspan="2">no</td><td colspan="2">0</td></tr>
<tr><td>Insurance [c]</td><td colspan="2">no</td><td colspan="2">24</td></tr>
<tr><td>Total [d]</td><td colspan="2">for 48 unique combinations of quality wheat</td><td>505</td><td>733</td></tr>
</table>

[a] Seeds and propagating material
[b] Machinery costs cover fuel, lubricants and repairs and – if a contractor is hired – also the labour costs charged for that work and the aliquot purchasing costs
[c] Insurance against natural hazards
[d] Neither of the 48 combinations assumes simultaneously the minimum or maximum values for all cost items, hence the individual cost items in this table cannot simply be summed up.
[e] PPI = plant protection intensity
[f] OwnLab = all work is carried out using own machinery and labour;
HirLab = specific work is carried out by a contractor using their machinery and labour, all other work is performed using own machinery and labour
[g] Variation is due to yield level

Source: OWN TABLE, 2015

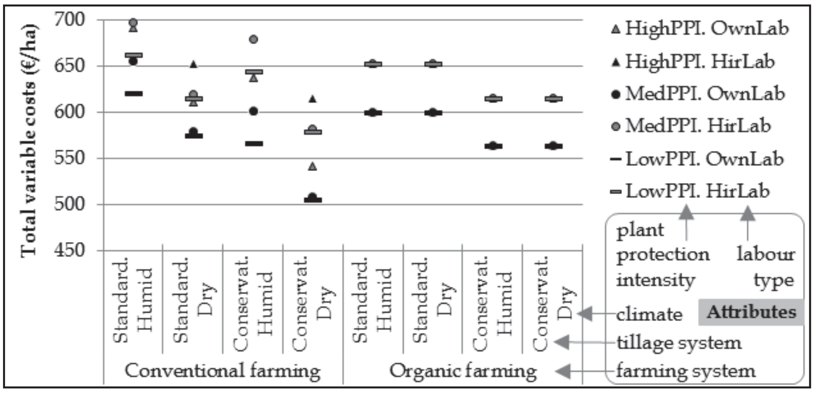

Fig. 1: Variable costs for 48 combinations of quality wheat production (no straw recovery, cropland, field size: 2ha, tax excluded) in the baseline period (avg 2011-2013), €/ha

Source: OWN FIGURE, 2015

4. Summary, discussion and outlook

The paper presents INCAP (Index-based Costs of Agricultural Production), a new data set to explore costs of all important agricultural activities in Austria. Based on existing data collections, INCAP extends the scope in several aspects. First, in accounting for a wide range of attributes and management variants, the data allow to represent revenue and cost structures of almost any farm in almost any region in Austria. The data are therefore useful for both farm-specific analyses and aggregate spatially-explicit analyses. Second, the time dimension is accounted for (2005-2050) and thus it is possible to generate consistent data sets for arbitrary base year periods and future years.

A more elaborated data set will be made available to the public as a spreadsheet file. INCAP's primary purpose is its use in farm and sector models for Austria but it could also be used for many other purposes. As shown in the literature, the cross-sectional and time dimensions of such data sets are very valuable in analysing uncertainty and risk in agricultural production systems. With minimal additional efforts, the data can also be used for farm-specific cost analyses when bookkeeping data are not available.

Besides these strengths, INCAP's limitations must also be taken into account. Constant farming technology (expressed as machinery costs per application and hectare) and methods (e.g. number of plant protection applications) were assumed throughout the timeframe in order to achieve consistency. These assumptions may however be adjusted in order to examine the effects of technological change. Most of the data are based on observations and are therefore empirically valid in a certain sense, however various cost items depend on specific technology assumptions and experts' judgements. In order to improve INCAP's validity, it will be necessary to systematically compare INCAP with activity-specific costs observed on farms. Contrary to countries where the latter exists (e.g. Switzerland), this cannot be accomplished for Austria at present since activity-specific cost accounting data are not available. Once INCAP is published, a first step is taken to close this information gap. The work on INCAP may stimulate the discussion on the value of specific cost information and thus contribute to a better understanding of the specific agricultural situation in Austria.

Acknowledgements

The work on this publication was supported by the project 'Adaptation in Austrian cattle and milk production (ADAPT-CATMILK)', funded by the Austrian Climate and Energy Fund within the Austrian Climate Research Programme (ACRP, contract no. KR13AC6K11112).

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Affiliations

Mag. Karin Heinschink PhD and DI Dr. Christoph Tribl
Federal Institute of Agricultural Economics
Marxergasse 2, 1030 Wien, Austria
Tel.: +43 1 877 36 51-7436
eMail: karin.heinschink@awi.bmlfuw.gv.at,
christoph.tribl@awi.bmlfuw.gv.at

Priv.-Doz. DI Dr. Franz Sinabell
Austrian Institute of Economic Research
Arsenal Objekt 20, 1030 Wien, Austria
Tel.: +43 1 798 26 01-481
eMail: franz.sinabell@wifo.ac.at