Digitalized Agricultural Technology in the AgTecCollection in mediaTUM®[1]

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Analogue agricultural technology

Science is the gain of knowledge, is the development of facts and dependencies. In the application-oriented research of agricultural engineering, this is done using existing, newly developed, or even visionary technologies. The results are written down in written form, illustrated in pictures and/or documented in the measurement data and their processing algorithms for application. They are the basis for follow-up work. According to SANTAYANA, 1905 [1], "Those who cannot remember the past are condemned to repeat it". However, since today mostly only digital information is known and often only this information is used in the science of today, analog knowledge must be transferred into the digital world of tomorrow.

Analogously documented knowledge is available worldwide at an infinite number of research units. However, this knowledge is in great danger of being lost. Here, the use of new technologies is the main factor determining what happens. Until the 1990s, slides were the dominant medium for knowledge transfer in research and teaching, but after a short period of overhead use, the transition to digital media took place. In many cases, only what was urgently needed was digitized; everything else was forgotten or disposed of. But even when research units are closed, almost everything that is still available is still being thrown away, often out of time pressure and without consideration. The same is true for new appointments to research units, when rededications take place, or the new person has other interests and/or sets different or new priorities. In addition, almost all research units lack clear rules for the treatment of estates, or of relevant documentation and archiving.

Digitization

Specifically, at our former Institute for Agricultural Engineering at the TUM in Weihenstephan, exactly these problems became visible as early as 2000. On the one hand, previous analog representations had to be converted to digital forms for teaching purposes. On the other hand, the university

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[1] A contribution from the CIGR IAABE Academy

management discussed a possible closure of the institute. So, what to do in this situation, looking back on almost 60 years of research and teaching at this institute and always in the same building with all that has been created?

For example, from its foundation in 1955 up to and including 1989, almost 11,000 manually produced technical drawings were created. A further 4,100 digitally created technical drawings supplemented the existing inventory. Of these, 1,800 slides had been created. In addition, there were about 45,000 mainly color picture slides, arranged in slide cabinets, with contents of all agricultural techniques from manual work to full mechanization of agriculture. In addition, more than 400 diploma theses and more than 100 dissertations described the intensive scientific occupation with all these techniques. Their results have been presented to the practical and scientific community in several 100 publications.

In order to save all these holdings, digitization was implemented in the following four phases in cooperation with the Library of the Technical University of Munich [2] (Table 1):

Table 1: Phases, time spans and responsibility of digitization and archiving

Phase	Time span	TUM Library	Chair of Agricultural Engineering
1	2000 - 2003	DFG application "Development of a media and publication server mediaTUM"	Digitization of 1000 test slides with EXCEL-based capture and archiving system
2	2003 - 2006	System development mediaTUM® and provision for test-installation of digitized images and fonts with meta data schemes specific to agricultural technology	Digitization of all slide stocks Chair of Agricultural Engineering TUM (LTW) and Chair of Agricultural Machinery TUM (LTM) with acquisition of all image specific meta data
3	2006 - 2009	System extension mediaTUM® with development of a suitable classification, transfer and integration of the created digitized material with the corresponding EXCEL metadata tables	Completion of digitization, duplicate analysis, metadata addition in EXCEL tables, transfer to mediaTUM®, test development and publication in the "internal area"
4	2009 - today	Development of search algorithms, special tools for citation, creation of access and download statistics, extension by English language	indexing and publication "Images and writings agricultural machinery in the AgTecCollection in mediaTUM®", extension by integration of films and videos and by research data

Indexing and publication

Beginning in 2009 in continuation of the test indexing of 2004, an indexing and publication of almost 45,000 slide digitized images in the AgTecCollection in mediaTUM (https://mediatum.ub.tum.de/agteccollection) was carried out over several years. For each digitized slide in the metadata, if available, the required data were entered into the following fields: Document type*, subject, title, keywords*, commentary, authors, year (yyyy), date (dd.mm.yyyy), brand, language, color*, author, origin*, image number, illustrator, source title, source author, source year (yyyy), source pages, link address, link display text, year of acquisition (yyyy).

The digitized documents were indexed and published in the same way. The following information had to be entered as required data: document type, author(s)*, editor, title*, title supplement, volume/part volume, abstract, Dewey decimal classification, project, institution*, publisher/institution, place of publication, publication date (dd.mm.yyyy), year (yyyy)*, year/month (yyyy-mm), month, pages/volume, print-ISBN, series title, serial-ISSN, serial volume number, language, link address, link display text, notes, copyright information, internal ID, TUM institution, stand-in, semester, format, input (dd.mm.yyyy), last change. For images and documents the fields marked with * are mandatory.

All activities for indexing and publication are documented and accessible in year-specific "activity listings" (https:///mediatum.ub.tum.de/?item=11274_19.html). They can be accessed and traced directly via integrated links. The development of the publication figures is shown in Fig. 1.
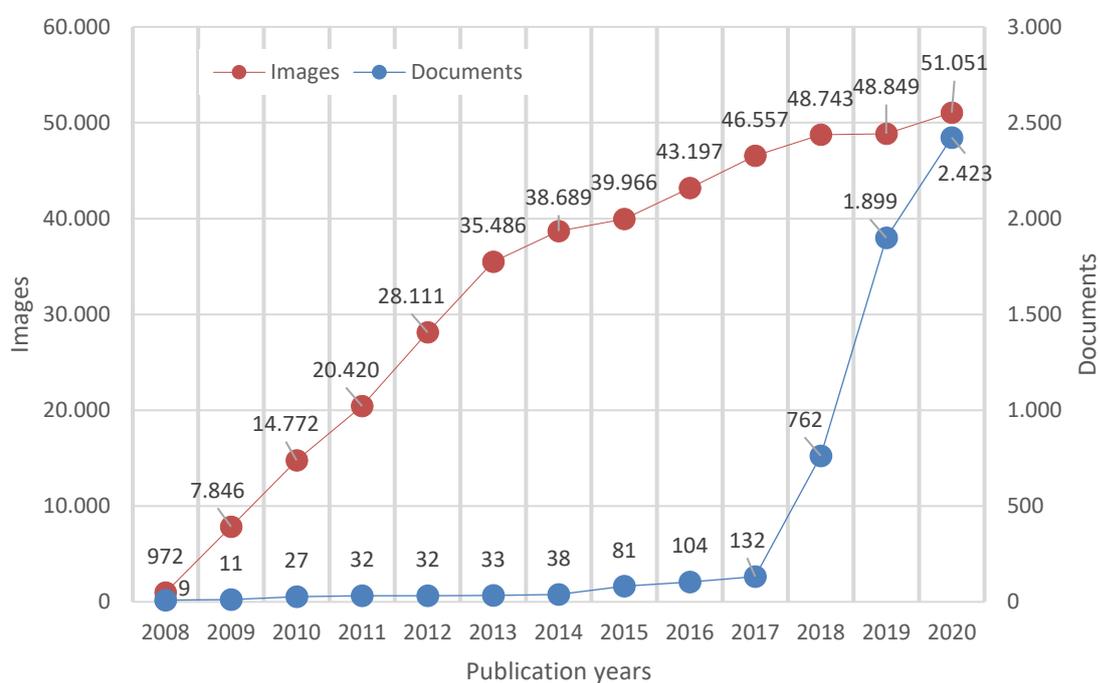
Figure 1: Publications, images, and documents 2008 to 2020 (as of 31.10.2020)

If the metadata "Document Type" is used for an analysis of the contents in images and documents, the objects shown in Table 2 result again as of 31.10.2020.

Table 2
Published images and documents by type, number, and relative share (as of 31.10.2020)

Images			Documents		
Type	Number	%	Type	Number	%
Photography	31,537	61.72	Books and Book contributions	191	8.03
Overview	3,634	7.11	Conference contributions	370	15.56
Schematic diagram	9,217	18.04	Magazine articles	730	30.70
Diagram	6,177	12.09	Research reports	459	19.30
Maps	528	1.03	Dissertations & Theses	628	26.41

Accesses and downloads

With the help of the available statistics tool, monthly access and download figures could be retrieved and documented from the beginning of the publication in 2009. These were limited to 50 objects each and referred to individual objects on the one hand and countries on the other. In addition, total access and total download figures were determined. However, the statistics tool was deactivated in spring 2019, which is why the corresponding results can only be derived up to this point.

With regard to accesses and downloads by country, Fig. 2 shows the development from 2009 to 2018.
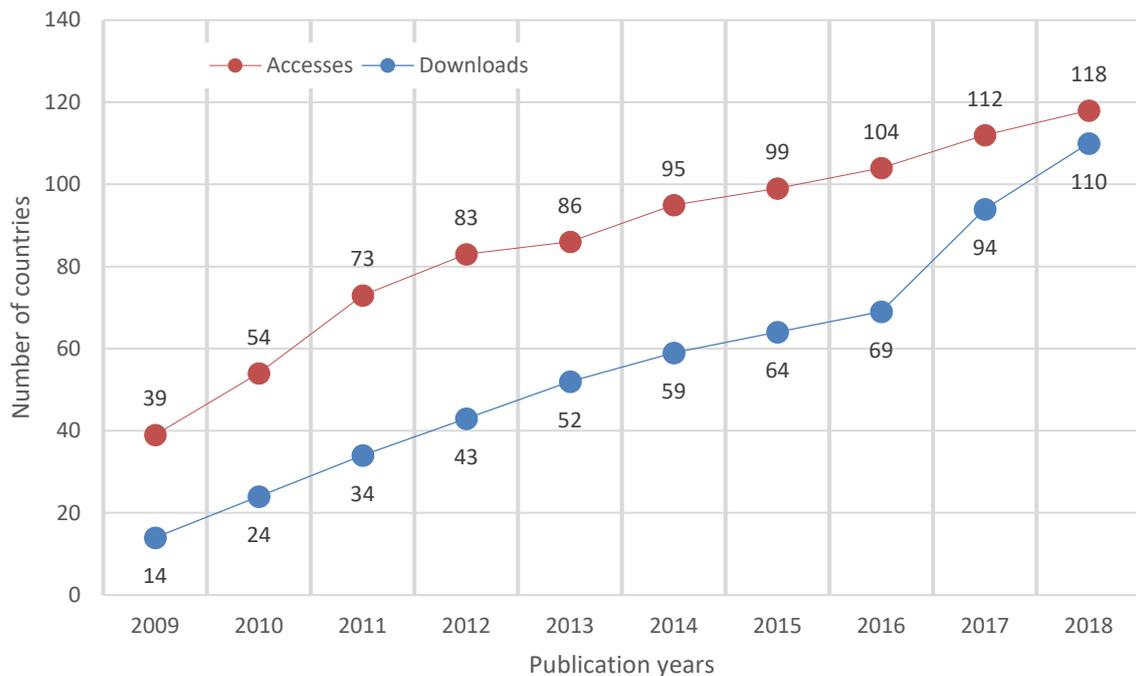
Figure 2: Access and download numbers from 09/2009 to 12/2018

Interesting in this connection is the analysis after Downloads of newly added countries related to the publication years, in order to be able to estimate from it the world-wide use (table 2).

Table 2
Newly added countries for downloads by year

Jahr	Countries added
2009	Austria, Belgium, Switzerland, Germany, France, Italy, Netherlands, Romania, Luxembourg, Latvia, Poland, Thailand, Bosnia and Herzegovina
2010	Denmark, Norway, Iran, Spain, United States, Canada, China, Czech Republic, Serbia, Slovak Republic
2011	Croatia (Hrvatska), Slovenia, Estonia, Finland, Great Britain (UK), Japan, Sweden, Turkey, Hungary, Bulgaria
2012	Satellite Provider, Syria, Liechtenstein, Oman, Lithuania, Russian Federation, Brazil, Armenia, Israel
2013	Greece, Portugal, India, Lebanon, Colombia, Ukraine, Mexico, European Union, South Africa, Taiwan
2014	Ireland, Singapore, Turkmenistan, Egypt, New Zealand, Kuwait, Iceland

Jahr	Countries added
2015	Australia, Azerbaijan, Korea (South), Philippines
2016	Argentina, Aland Islands, Chile, Macedonia, Malaysia
2017*	Indonesia, United Arab Emirates, Morocco, Hong Kong, Kenya, Suriname, Vietnam, Cambodia, Moldova, Mongolia, Algeria, Uganda, Cameroon, Peru, Pakistan, Venezuela, Bangladesh, Belarus, Papua New Guinea, Dominican Republic, Ethiopia, Guatemala, Kazakhstan, Bolivia, Jamaica
2018	Ivory Coast, Paraguay, Tanzania, Uruguay, Uzbekistan, Rwanda, Namibia, Saudi Arabia, El Salvador, Yemen, Albania, Kyrgyzstan, Guinea, Nepal, Panama, Iraq

* Nov 2016: English Keywords were added to all images

The absolute numbers of downloads and the intensity of the respective country with download months can also be derived in detail from these statistics (Table 3).

Table 3
Top 10 countries with absolute downloads and share and with download months
with share from 2009 to 2018

Rank	Code	Country	Download numbers	%	Download Months	%
1	n.a.	Not addressable	161,946	38.29	110	99.09
2	DE	Germany	156,251	36.95	111	100.00
3	US	United States	61,849	14.62	83	74.77
4	AT	Austria	15,975	3.78	108	97.29
5	CN	China	3,981	0.94	34	30.63
6	CH	Switzerland	3,462	0.82	95	85.58
7	NL	Netherlands	3,004	0.71	98	88.28
8	PL	Poland	2,068	0.49	89	80.18
9	GB	Great Britain (UK)	1,299	0.31	55	49.54
10	OM	Oman	1,223	0.29	4	3.60
…	…	…	…	…	…	…
110	IQ	Iraq	1	0.00	1	0.00

Comprehensive access and download statistics by individual objects for different time periods and for specific object sources or authors can be viewed at https://mediatum.ub.tum.de/1078037.

Altogether it can be stated from these analyses that the created "Collection of Images and Documents Agricultural Engineering" meanwhile meets with great interest worldwide in addition to a very strong use from Europe. The download figures illustrate the need for the available information, although individual continents show very different behavior. For example, countries in the northern hemisphere are very intensive users, while Africa and South America in particular are very reluctant to respond.

Further actions and open questions
Although the available stock of writings is now largely catalogued and published in the AgTecCollection, further extensive publication activities are still pending. More than 10,000 technical drawings are still

waiting to be catalogued and published. They consist mainly of schematic representations, diagrams, and overviews. Photographs and technical drawings will then be available in roughly equal proportions in the collection.

In addition, the area of research data requires increased attention. Here too, initial publications on the studies carried out in 2007 to analyze the behavior of farm animals on alpine pastures with the aid of GPS sensors and pedometers are showing worldwide interest (https://mediatum.ub.tum.de/?id=1470874). The same applies to the local yield determination in harvesters and the yield maps published for this purpose from 1990 to 2000 (https://mediatum.ub.tum.de/1575449). Their original measurement data are currently being processed and will soon complete the necessary information.

In addition, it is intended to include available film and video material from the trials in the collection. As an example, the layout and use of a measuring stand for the determination of ingredients by NIR during swath scanning is to be started (https://mediatum.ub.tum.de/1297464).

And last but not least, general efforts of the community worldwide are required to make all available and planned archiving projects accessible and usable in a superordinate system. User-specific languages, keywords and above all an intelligent search system are only the first important requirements to be mentioned here. As an example, we refer to the presentation of publications created for this purpose (https://mediatum.ub.tum.de/?item=1304963_0.html). Only then would it be possible for everyone to use the digitalized knowledge from the analog agricultural age and to incorporate it into their own research and developments.

Literature

1. Santayana, G. (1905): **The Life of Reason**, p. 284

2. Auernhammer, H., Seifert, A., Teichert, A., Bernhardt, H. (2013): **Digitalisierte Bilder und Schriften Agrartechnik in der "AgTecCollection in mediaTUM®"**. In: Referate der 33. GIL-Jahrestagung 20. - 21. Februar 2013, Potsdam "Massendatenmanagement in der Agrar- und Ernährungswirtschaft Erhebung - Verarbeitung - Nutzung" (Hrsg. Clasen, M., Kersebaum, K. C., Meyer-Aurich, A., Theuvsen, B.), Bonn, 23-26