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Abstract: Large-scale, high-input, and intensified agriculture poses threats to sustainable agroecosystems and their inherent biodiversity. The EU Common Agricultural Policy (CAP) covers a great number of nature conservation programs (Agri-Environment and Climate Measures, AECM) aiming to encourage sustainable agriculture. Currently, farmers are not encouraged to broadly implement these measures due to the lack of structured information, overly complicated and unclear application procedures, and a high risk of sanctions. In addition, the current structures are associated with time-consuming monitoring and control procedures for the paying agencies. Digital technologies can offer valuable assistance to circumvent relevant barriers and limitations and support a broader uptake of AECM. NatApp is a digital tool that supports and guides farmers through the complete process of choosing, applying, implementing, and documenting AECM on their fields in accordance with legal requirements in Germany. We introduce the concept of NatApp and analyze how it can simplify and encourage the uptake and implementation of AECM. This study identifies its unique features for the provision of information and documentation opportunities compared with other digital farming tools focused on sustainable agriculture and outline how it can support farmers to actively contribute to more sustainable agriculture.

Keywords: digitization; app; agriculture; AECM; CAP; geotagged photos; nature protection

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1. Introduction

Agricultural intensification and land-use change are major drivers of biodiversity loss and decline in agricultural landscapes [1]. They lead to increasing fragmentation of natural habitats and their underlying functions, reduction of valuable patch sizes and their isolation, and a significant decrease in pollination levels, species diversity, and the populations of individual species [2].

Over the last decade, the protection of biodiversity has gained importance within CAP of the European Union (EU). The CAP is built on two pillars. The first pillar focuses on direct payments (per hectare) granted to farmers when the required preconditions are met. These preconditions are operational management requirements on the farms (Cross Compliance) and result from the EU guidelines for the protection of nature, the environment, and animals, as well as the standards for the conservation of areas in a "good agricultural and ecological condition" [3]. The second pillar covers targeted development programs for sustainable and environmentally friendly cultivation and rural development [3,4]. The schemes of AECM, an integral component of the second pillar, provide financial support for EU Member States to design and implement measures to mitigate biodiversity loss and increase environmental protection [5].

AECM represents one of the main instruments for achieving the environmental objectives of the CAP. In addition to their contribution to environmental and climate protection, the focus of these measures is the preservation and increase of biodiversity, the improvement of soil structure, the reduction of fertilizer and pesticide inputs, especially close to sensitive waterbodies, and animal welfare [3]. AECM can be nationwide, such as fallow land or buffer strips in Germany, for example, or region-specific, where individual regions propose their own catalog of measures. For instance, in the federal state of Bavaria in Germany, fallow fields with self-greening for species protection are promoted, while in Thuringia, support is provided for perennial flower strips at the field edges. The AECM also vary in their extent in the fields: they may focus on large-scale extensification, such as extensive grassland management, as well as small-scale, field-integrated conservation measures, such as copses, kettle holes, or cairns [6].

Despite those efforts to reduce the negative effects of intensive agriculture, several studies demonstrate that the past CAP system with its programs and measures did not have a sufficient and notable effect on biodiversity and the environment, as expected. Measures incorporated in the first pillar were, in many cases, too dilute to have significant ecological impacts [7]. In particular, the conservation areas of the greening program, such as nitrogen-fixing crops and green cover, did not contribute directly to the enhancement of biodiversity but likely led to further intensification of European arable land management and depletion of farmland biodiversity [8]. Another weakness was the great number of exemptions and possibilities to circumvent the regularities. Within the EU, member states were required to identify and protect ecologically valuable grassland within protected sites, but outside these areas, farmers could still convert low-input, species-rich grassland into highly intensified, species-poor swards while receiving EU subsidies [7]. Furthermore, the procedure and legislation failed to address different target stakeholders, and a large number of farmers were excluded from the application of conservation measures. There was a lack of differentiation among regions and grassland types and a focus on net area without consideration of continuity and connectivity of existing seminatural grassland parcels [7–10]. A strengthened second pillar, as well as landscape-targeted and coordinated programs, for actions among the farmers are important tools to reach sustainability goals on a larger scale [9]. Conservation actions can be more targeted by the continuation of AECM and the introduction of eco-schemes [11].

Against this political background, science emphasizes the importance of mosaic structured agricultural landscapes. A number of research studies underline the significant contribution of small-scale, field-integrated conservation measures to preserve and enhance biodiversity in managed farmland [5,8,12,13]. Natural elements, such as grassland buffer strips, small patches of uncropped land/open soil, woody hedges, or flower-rich habitats, have been demonstrated to be valuable tools for halting the continuous loss of biodiversity. The establishment of habitat heterogeneity by the integration of semi-natural habitats is essential for regions of large crop fields and the conservation of otherwise naturally occurring farmland biodiversity [8,12].

These conservation elements are site-specific and highly compartmentalized; hence, they have only minimal impacts on the levels of agricultural production, and even so, the gains in local ecosystem services presumably offset potential production losses [8,14]. Furthermore, they show considerable content variability and flexible and nuanced management schedules [12,15]. A great portion of these small-scale, field-integrated conservation measures are integrated into AECM, and their implementation can be fostered with financial incentives, as well as clearer application procedures.

Currently, the complicated and elaborate application procedures, as well as the strict guidelines associated with the measures, often prevent farmers from implementing AECM. There is a need to improve and structure the provision of information about ecological objectives and funding contents [16] and keep it updated at all times. To date, no organized information system about AECM exists [16]. The application process is a highly bureaucratic procedure that requires much time and effort from farmers. For example, in Germany, each federal state has its own application system or software, and application formats are very complex and unclear in their structure [17,18]. Consequently, the great uncertainty on the farmers' side concerning the complex funding requirements and guidelines discourage the uptake of AECM. Due to the strictness of the guidelines, farmers fear occasionally high sanctions [19]. Additionally, they criticize the limited practical relevance of the programs [14,16,20]. In terms of the application and implementation of nature conservation measures, the current situation unveils the demand for a better structure and greater clarity of the programs and the conditions that apply in individual cases [9,21].

The hurdles exist not only on the farmers' side but also on the paying agencies' side. The present random area-based payment monitoring system is very time- and personnel-consuming due to the necessity of 'On The Spot Checks'. Not to mention, the associated administrative burden is huge [22–24].

With regard to the environmental challenges and bureaucratic obligations that farmers and paying agencies are currently facing, digital tools can offer valuable assistance to circumvent relevant barriers and limitations. A great number of digital technologies for farmers already exist [25–27], with the potential to improve the ecological footprint of farming practices via, for example, precision farming and to increase the profitability of agribusinesses. These tools provide valuable and comprehensive assistance on farm mapping, management, and monitoring [26,28]. They are available mostly in the form of apps assisting farmers in specifying their field operations, defining the optimal seeding or harvesting dates, and providing a better overview of their farms and the corresponding data [26]. However, tools specifically for assisting with the planning and implementation of AECM in agricultural landscapes are, to our knowledge, scarcely available on the market or mentioned in the literature.

To fill this gap, we developed the NatApp with the aim to offer an easy-to-use and free-of-charge tool that provides structured and clear information about possible AECM options suitable for individual farms and ultimately encourages on-site biodiversity. The aim is to offer an easy-to-use and free-of-charge tool that provides structured and clear information about possible AECM options suitable for individual farms and ultimately encourages on-site biodiversity. NatApp aims to facilitate the bureaucratic and unclear application procedure of AECM for farmers, as well as to reduce the management burden for the paying agencies.

The objective of this paper is to present and critically evaluate NatApp as an appropriate instrument to close the gap for a convenient digital tool to foster the uptake of small-scale, field-integrated measures via a transparent information provision and application process. To evaluate this, we explore how NatApp compares with other tools, considering their contribution to foster biodiversity in agricultural landscapes via AECM or other nature conservation measures. First, the concept and modules of NatApp are presented. Subsequently, NatApp is compared with other digital tools available on the market that also aim to reduce the negative impacts of agriculture on the environment or even encourage the implementation of nature conservation measures. Within this analysis, the strengths and weaknesses of NatApp are discussed. On the basis of our analysis, we provide conclusions on the potential contribution of apps, such as NatApp, toward more sustainable agriculture and a positive shift in EU agricultural policies.

2. The NatApp

2.1. Development of the NatApp Concept

The development of NatApp went through several stages. The first idea of NatApp emerged in 1998, when concepts for improving the maintenance of plant and animal species typical for agricultural landscapes were planned and presented. Next, the developed ideas and concept were published in a manual for the arrangement and optimized cultivation of small-area habitats for biodiversity [29]. Before every following project phase, the provision of digital tools on the market having the same aim as the NatApp was verified. A first transfer of the thus-far developed concept toward a digital support tool took place a few years later, when a smartphone-based documentation of nature conservation measures on fields and grassland was designed [30]. The development of the first prototype took place in close collaboration with the AECM responsible agencies at the county and state levels in Germany, the German organization for nature conservation, and the midsize company for agricultural soft- and hardware, HELM Software. During a subsequent period, the options of transfer and adaptability, as well as the acceptance of NatApp among farmers, were investigated. The aim was to discover the possible suitability of NatApp for selected and exemplary nature conservation measures [14,20].

In the current phase, started in September 2020, NatApp is being tested on 20 selected pilot farms in Germany to evaluate its applicability and investigate its acceptance among farmers. The farms, chosen by the German farmers' association, are distributed in the four federal states of Bavaria, Brandenburg, North Rhine–Westphalia, and Thuringia. Due to their wide-ranging geographical distribution over the four federal states, the pilot farms operate under very diverse natural conditions. Hereby, NatApp was developed, considering the diversity of farmers' needs. All tests of the pilot version were conducted on the pilot farms, and the farmers' feedback on the modules that were tested was integrated in the further configuration of NatApp. The targeted open-source versions for Android, as well as iOS systems, were designed in close collaboration with them. The setup of NatApp was based on web, as well as app, application modules.

2.2. Main Modules of the NatApp

NatApp consists of four main modules: (1) the information desk (Infothek), which offers a catalog of possible nationwide and federal state-specific AECM from which farmers can choose; (2) the planning tool, which supports farmers with the application of AECM by drawing on standardised geometric data (ESRI shape files) of established, federal state specific application software programs (Integrated Administration and Control System–IACS); (3) the monitoring tool, which assists farmers with the implementation of AECM by providing guidance during the implementation; and (4) the documentation tool, which offers geotagged photos and recordings of the implementation process (Figure 1).

2.2.1. Infothek

The Infothek (1) is one of the main new technical contributions of NatApp to an easier application and implementation procedure of AECM for farmers. It is a web-based, nationwide collection of AECM catalogs, from which farmers can choose the most appropriate measures for their fields. The access is public, and the information is immediately available. Instead of the maze of various available sources for the provision of information on AECM, such as online sources, paper documents, and counseling services, it offers a unique reference with up-to-date information and relevant guidelines in a uniform, clear and systematic structure. The aim of the Infothek is to supply suitable and comprehensive information to farmers not familiar with the implementation of AECM.

Several filter functions support farmers with their research in the Infothek. A first prefilter is the appropriate federal state. AECM are then listed in an overview, distinguished according to their field of application: arable land or grassland. As an alternative to this overview structure, AECM can also be prefiltered and individually adjusted by the criteria of geographical validity, area (arable land, grassland, or other measures in the open field), location (water/forest edges), shape (strip or larger area), measure characteristics (width and length), bonus, duration, and funding program.

Each AECM is accompanied by the following information: general information, application, funding program, area allocation, area establishment, obligations, and other information, such as the amount of funding and the ecological benefit. The provided information contains all respective details on the individual measure. Therefore, farmers can receive information that is as concrete and comprehensive as possible prior to the implementation of the AECM in their fields.

Via the Infothek, farmers can easily browse through the updated catalog. In the most user-friendly format, Infothek is called up as a web application. It is also possible to view Infothek as an app application on the digital device on hand in the field, but with a less comfortable overview of the catalog. Once a farmer has chosen a certain AECM to implement, they subscribe to the measure, and it is then saved in the documentation tool (Section 2.2.4). The next steps for the implementation of the AECM take place in the planning tool (Section 2.2.2).

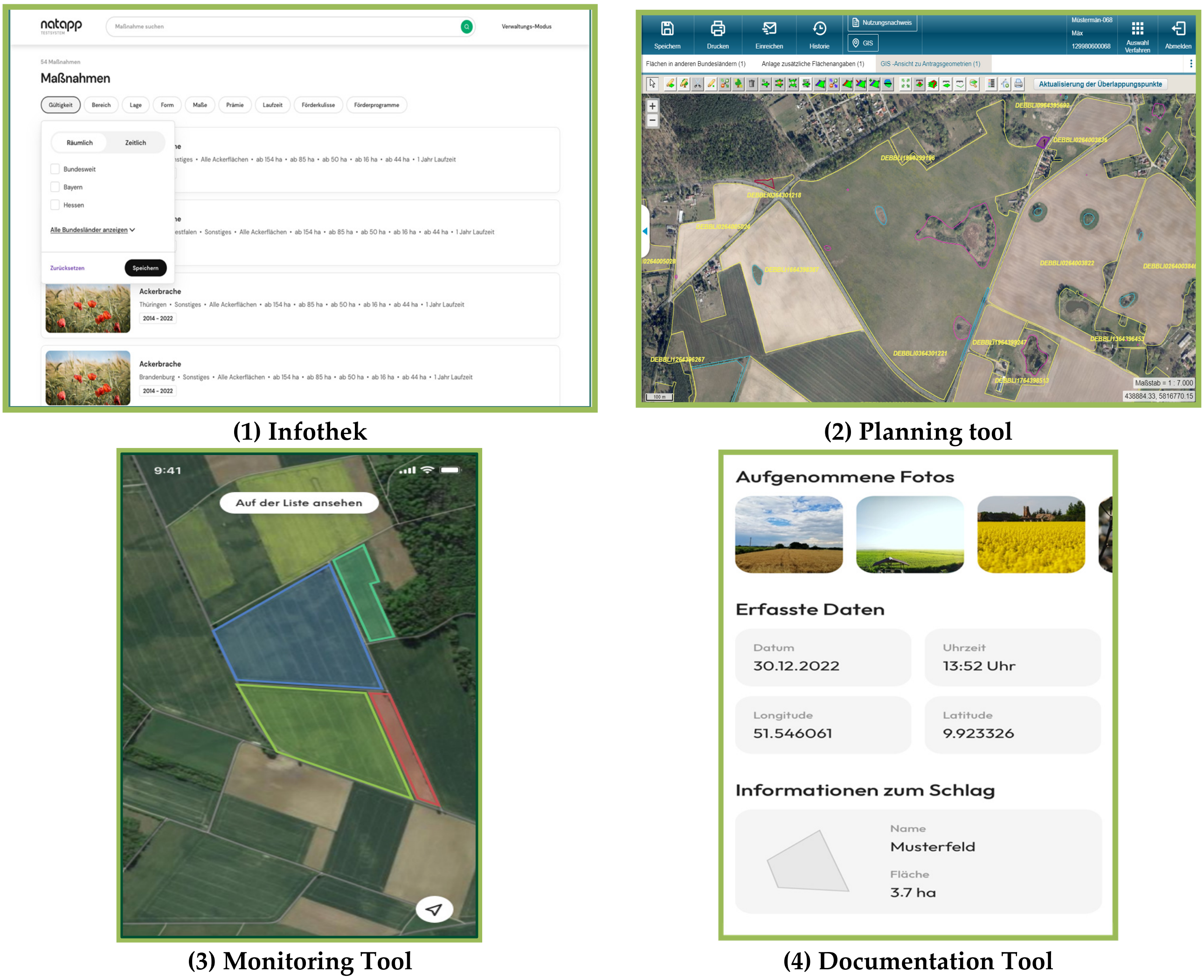

Figure 1. Overview of the NatApp concept and modules.

2.2.2. Planning Tool

In the planning tool (2), users can import the subscribed measures and corresponding plots and manage the implementation of those measures. The planning tool is designed as a web application. With its help, farmers can directly apply for selected AECM via direct access to the IACS digital application software of each federal state [14,30]. All relevant farm and plot data deposited in the IACS system are imported as shape files into the planning tool and are synchronized with the measurement information of the selected AECM. Therefore, farmers do not need to re-enter their plot data in NatApp. The IACS software includes up-to-date references and information about each farm plot. By manually drawing in the Agrar Global Positioning System (GPS), farmers can add additional information, such as plot size or usage of the farm plots.

Another valuable feature of the planning tool is the implemented calendar and the automated push notifications. This combined reminder function is activated as soon as the selected measure is synchronized with the plot information. The calendar provides an overview of the individually selected measures, including the number and size of measures. It reminds and informs the user of upcoming management dates, as well as obligations to produce proof of the subscribed measures. The user has the option to tick fulfilled obligations. With the assistance of this tool, farmers face a lower risk of management mistakes and, therefore, a possible risk of sanctions.

The list of fields and subareas are highlighted with a GPS navigation function. Activating this button starts the navigation tool of the digital device, and the chosen field is easy to reach. This function is essential because it allows the identification of the selected plot for the implementation of the AECM without elaborate marks in the land. Furthermore, it provides vital guidance for external contractors or machinery staff who do not know the farm and its associated territory well. For efficient management, all binding zones with the same measures at the same management date are listed in one route.

2.2.3. Monitoring Tool

The monitoring tool (3) is conceptualized as an app application to be used directly on the plot. Once the user arrives at the selected plot, a plausibility check takes place immediately before entering the area. For the prevention of management errors, NatApp verifies whether the management measure is undertaken at the right time using the right machine in the right area. Therefore, possible sanctions due to incorrect management measures (for example, too-early mowing during protective restrictions for meadow breeders) can be avoided in advance. Arriving at the plot, NatApp also provides systematically edited information that is relevant for the actual management measure.

Once the farmer starts with the conduction of the AECM on the selected plot, the operation range and lane of the working machine are plotted in NatApp via a tracking function. It is a live recording, providing the ability to track the conduction of the AECM and, if applicable, correct it. On the one hand, in this way, the correct location and size of the eligible area are recorded for the paying agencies. On the other hand, the implementation of the management on the plot can be reconstructed by the farmer, and potentially forgotten patches can be reworked. This feature also assists farmers in correctly conducting the measure and avoiding undesired sanctions. After completion of the conduction, the recording is to be stopped. Before finally booking the recorded lane, NatApp asks if the records are correct or whether anything needs to be changed. Now, the users can calmly reconstruct their work and make any required corrections.

2.2.4. Documentation Tool

Via the documentation tool (4), the obligation to provide proof for declared area-based payment controls by the paying agencies was undertaken. The main part of the documentation took place in the field on the selected plot. Prior to the conduction of an AECM, a geotagged photo must be taken according to the European guidelines for geotagged photos [31]. As soon as the necessary management measures are completed, geotagged pictures must be taken again. NatApp advises the user where and how to take the pictures for legally compliant documentation. It serves as recorded evidence of the completed management of the selected plot. After a final review, geotagged photos, together with the GPS Track, will be saved as a zip file (.jpg, .pdf, or shape) on a cloud system and can no longer be manipulated in any way.

The cloud system is held and maintained by the central administration unit, e.g., the state. With the uploading of decisive data, such as the type of AECM, size, location, and photos, paying agencies can work much more efficiently. A great number of the time-consuming on-the-spot checks become redundant. Access to individual farm documents for monitoring and inspection purposes is only possible on request to farmers. On demand, the farmer will release the respective documents, and they are partly automatically processed. By this approach, farmers hold the main authority of their sensitive data and keep control over their transfer and dissemination.

The data generated by the documentation tool can be used not only as documentation but also as monitoring data for further projects and analyses, wherever monitoring data are needed.

3. Materials and Methods

To evaluate and analyze the benefits of NatApp within the range of digital farming assistance tools and contrast it to other tools, considering their contribution to fostering biodiversity in agricultural landscapes via AECM or other nature conservation measures, we conducted a rapid literature review process. The review focused on tools most similar in scope to NatApp, and it was conducted between July 2020 and May 2022, including findings from 2017 onwards. To identify relevant tools, a systematic internet search via "Google" and "Google Scholar" was conducted. In varying orders and combinations, the search terms "agriculture", "nature conservation measures", "app", "digitization", "digital tool", "agriculture 4.0", "agri-environment climate measures", "sustainable agriculture", "CAP", and "nature protection" were used. In addition to the keyword search, the latest digital developments quoted on the homepages of established agricultural or industrial companies (e.g., Bayer or Bosch) were explored. Further information was gathered on the homepage of the EU, as well as those of the German Federal Ministry of Agriculture and the German Federal Environment Ministry. Via snowball sampling, various other resources opened up, such as the websites of agricultural fairs. The research was undertaken in English. Therefore, our search was limited to English-written papers, homepages, and other publications. Country-specific tools that have been published in their country-specific language, therefore, were not considered in this paper.

After a first overview, only one other tool directly focusing on the documentation of subsidized AECM within the framework of the CAP was found. None of the other tools was directed at the implementation of AECM or nature conservation measures in general. Therefore, the scope of our search was broadened, and digital tools that focus on other aspects to enhance nature and environmental protection in agricultural landscapes and contribute to sustainable agriculture were considered. Such aspects were, for example, climate change mitigation, carbon sequestration, precision farming with reduced fertilizer and pesticide inputs, or specialized monitoring features, such as biomass maps for optimal crop management. This broader approach was chosen to analyze the applied format and features of the less similar digital tools compared with NatApp.

With this research, 35 available digital tools, representing a snapshot in time of the tools available on the market at the time of the review, were chosen. Of these tools, we selected six that were analyzed in more detail with respect to their technical details and format. The selected tools were those that have the greatest orientation and agreement on our search criteria of supporting the implementation of nature conservation or sustainable agriculture. The need to define the state-of-the-art technical and format criteria in a comparative analysis of digital farming tools emerged as an important requirement in surveys conducted in earlier phases of the NatApp project. During these surveys, farmers indicated that to be successfully implemented, digital tools for nature conservation need to reduce their bureaucratic burden within the scope of the CAP and be easily integrable into their daily business. Therefore, we focused on technical features and formats to facilitate applications for AECM/nature conservation. Regarding technical features, we investigated: (i) Which approach do the tools use to get to their target output (e.g., photos, satellite images, GPS system, etc.)?; (ii) How do they provide assistance (e.g., are they guided by GPS or help with the documentation of the measures)?; (iii) Which data do they rely on for their operations (e.g., field data or whole farm data)?; and (iv) Which additional valuable features do they offer to farmers (e.g., calendars or additional map features)? With respect to their format, we explored: (i) In which format are they available: as a mobile app or web application?; (ii) Are they free of charge or fee-based?; (iii) On which software system are they running (i.e., Android or iOS)?; and (iv) Which other user-friendly format or extras do they offer?

4. Results

Of the six reviewed tools, as mentioned earlier, the target scope to support the implementation of AECM in the frame of the CAP could be found only in one of them (EGNSS4CAP) (Table 1). The target of this app is to improve the performance and reliability of CAP inspections, but unlike NatApp, it does not provide any service in the selection, application, and implementation of conservation programs and measures. The other five reviewed tools (Table 1) focused not directly on the implementation of nature conservation measures or reinforcement of biodiversity but on other aspects of sustainable agriculture. They incorporate, for example, farm-customized greenhouse gas (GHG) mitigation (COMET-Farm Tool; © United States Department of Agriculture (USDA)/Colorado State University, Washington, DC/CO, USA), locally climate and best environmentally adapted and most resource efficient and, therefore, sustainable maize production options (AgroTutor 2.0.1 (Android), © IIASA) or collection and mapping of farm data for carbon credits (Conservis Climate Field View 6.26.2.682204 (Android); 6.26.0 (iOS), © 2023 Climate LLC), optimal fertilization and plant management (CropSat), or reduction of management costs and used resources (Agricolus 3.16.1, Android app, © Agricolus srl).

Table 1. Comparison of selected digital farming tools' target scope.

Tool	Target Scope
EGNSS4CAP [32]; European GNSS Agency (GSA)	– Deployment of the European Global Navigation Satellite System (EGNSS (OSNMA, EGNOS/EDAS, HAS)) digitization in the reporting requirements within the scope of the CAP – Supports and complements European Geostationary Navigation Overlay Service (EGNOS (GPS L1)) and Copernicus Sentinel-based monitoring procedure for CAP
COMET-Farm [33]; United States Department of Agriculture (USDA)	– Active implementation of GHG mitigation actions on farms and carbon sequestering relying on the official USDA GHG inventory guidelines – GHG accounting system and comparison of current and future GHG emissions of farm management
AgroTutor [34]; International Maize and Wheat Improvement Center (CIMMYT)	– Providing benchmarking plot (location and crop) and weather information, also the Historical Yield Potential (historical, non-nutrient, and pest-limited yield potential estimated as a benchmark, derived a priori from crop model outputs for the time period 1980–2010) to small- and medium-size farmers across Mexico to adopt sustainable agriculture and higher profits – Indicating "windows of opportunity" (best times) for optimal agronomic management on the selected plot
Conservis/Climate Field View; [35]	– Analyzing tool for field data collected with Climate Field View or other different equipment – Matches data of applied methods on the field with input costs: provides hub of farm data – Collects and allocates data for carbon credits – Collects and monitors field data in real time – Realizes early detection of problematic patches within the cereal stocks
CropSat [36]; Vantage Agrometius	– Crop-sensing system – Crop variation visualization – Satellite-data-based partial area fertilization application maps for fertilization and crop protection based on biomass maps and biomass monitoring of the fields – Crop monitoring and agronomic management
Agricolus [37]	– Calculation of real need of crops, reduction of management costs and used resources, permanent monitoring of crops: prevention of climatic and parasitic complications

Some prevalent technical features to facilitate the application of AECM or other nature conservation measures include the use of sentinel data, as well as geotagged photos, geolocation, and GPS and mapping tools (Table 2). The EGNSS4CAP, for example, is based on the Copernicus and Galileo programs. Conservis, CropSat, and Agricolus also rely on sentinel data for the implementation of their features. Geotagged photos, geolocation, and GPS and mapping tools are used for assistance regarding either the documentation or display of conservation measures (e.g., geotagged photos of the EGNSS4CAP app or the geolocation and mapping tools of the COMET-Farm Tool, CropSat, and Agricolus) or the guidance to relevant field plots or sections (e.g., phone-built in GPS in the AgroTutor app) (Table 2).

Table 2. Comparison of selected digital farming tools' technical features.

Tool	Technical Features
EGNSS4CAP	– Geotagged photos (location and timing of the photo) – Galileo distinguishing features (Galileo dual-frequency)
COMET-Farm	– Spatial mapping, Google Maps drawing tools (pins) 1. Overlay with Web Soil Survey map units – Manual-driven, fully spatial GUI
AgroTutor	– Local data systems to measure and monitor specific indicators, such as the proportion of agricultural area under productive and sustainable agriculture; local, individual data, geolocation (phone's built-in GPS), and calendar feature
Conservis/Climate Field View	– Monitoring production and vegetation status via satellite images – Status reports on implemented activities and applied inputs, non-automatic soil samples, and historical yield data – Necessary field data is centrally captured and stored in the system for purposes of documentation
CropSat	– Satellite images for calculation of vegetation indices and variable rate applications; map and location features – Display of subcrop-specific differences in five levels
Agricolus	– Sentinel-2 satellite images – Geolocated data for field optimization, crop planning, and task management

All of the presented tools rely on the input of individual farm data for their calculations, although in a different range and scale. Some tools, such as the COMET-Farm tool, also rely on background data, such as climate or soil data, provided by state databases and accessible by the tools.

Another additional valuable feature for the users is the calendar function, also described as a status report. Especially for tools providing management suggestions, a calendar or other type of reminder function and status report is a valuable function (Table 2). It supports appropriate handling of the tool and the prevention of undesired results due to incorrect operation.

With regard to the format, the two typically occurring formats are an app application or a web-based platform (Figure 2). Interactive maps the farmers/users can employ for precise and comparative analyses of their fields are often available. Except for the Conservis/Climate Field View, all tools are free of charge, and if developed as an app application, most of them run on iOS as well as on Android devices. The user-friendliness of the COMET-Farm Tool, for example, is characterized by the cost-free availability of the tool and the possibility even for non-registered users to calculate their emissions and create mitigation scenarios. Some tools (Conservis/Climate Field View) offer freely available upgrade software for testing for one year.

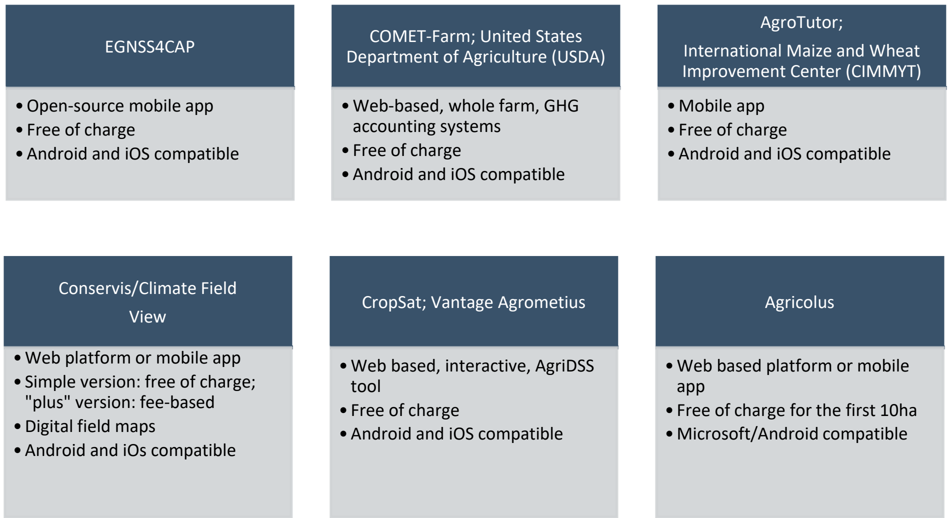

Figure 2. Comparison of selected digital farming tools' format.

5. Discussion

The present application, documentation, and monitoring system of AECM is highly valuable for nature conservation and is a very bureaucratic, unstructured, and time-consuming process associated with uncertainties and the risk of mistakes and failures with respect to the correct implementation of measures. At the moment, even if farmers want to implement AECM on their fields, most of them fail at the first hurdle of missing or not systematically preparing information about the implementation of such measures. In addition, the monitoring procedures for the paying agencies also need to be revised to become much more time- and personnel-efficient.

NatApp provides valuable assistance in this complex situation by facilitating users to easily and quickly obtain a better overview of possible AECM, to flexibly conduct individual planning steps for their fields, and to be guided systematically through the implementation and documentation of AECM valuable for nature conservation (Table 3). Unlike the EGNSS4CAP app, the target scope of NatApp is not only the fulfillment of obligatory documentation required by the paying agencies or the improvement of production patterns (CropSat, Agricolus) but also clearly a facilitation of access for farmers to edited information. In particular, the comprehensive, methodically structured Infothek with its up-to-date information is a unique and outstanding feature of NatApp compared with other digital tools. NatApp also aims to encourage farmers to participate actively and voluntarily in ecologically beneficial AECM, best fitting for their fields.

Although some other tools rely partly on more advanced technologies/technical features, such as geotagged photos applied in NatApp (e.g., Galileo and Sentinel data and images), gradual guidance through the entire application and documentation process of AECM in the documentation tool is a highly useful and advantageous feature for individual users. An important service is the automatic synchronization of relevant farm and plot data deposited in the IACS system with the measurement information of the selected AECM. NatApp provides several setups for safe utilization and avoiding mistakes. One of them is the automatic verification of the correct location (right machine on the right plot) by the app prior to the implementation of an AECM. Hence, even external contractors or machinery staff, who do not know the farm and its associated territory well, can conduct an AECM, selected by the farm manager. The live recording of the implementation is always cached and, thus, allows the user to review the record and, if needed, correct it. Likewise, to lower the risk of management mistakes and possible sanctions, an implemented calendar and automated push notifications remind farmers of important management measures. Finally, to ensure legally compliant documentation, NatApp precisely advises the user where and how to take geotagged pictures before and after the implementation of an AECM. With regard to the format, there is no significant difference between NatApp and the other digital tools. NatApp is also free of charge and runs on iOS as well as on Android devices. Of course, there is a difference in the spatial usability of NatApp, as it works with only German nature conservation databases.

Table 3. Advantages and disadvantages of NatApp.

	Advantages	Disadvantages
Target Scope	– Focus on the very important topic of AECM in the CAP, focus on a field, where action and change are urgently necessary. – Provision of structured information about AECM (Infothek), creates incentives for farmers to actively commit themselves for biodiversity protection. – Transferable and adaptable to a great number of other projects where a monitoring tool is needed.	– Measures and requirements within the CAP are a dynamic and ever-changing realms → political and structural changes need to be included in the NatApp. – Digital tools can only support the users but never replace the advice by trained staff.
Features	– Link to established technologies in agriculture (e.g., digital field map, access to the IACS), load of already entered data.	– Not running on the latest technical capabilities; sentinel data, satellite images, and AI developments made great progress in the last several years → challenge to adjust the NatApp.
	– Valuable information and planning assistance. – Detailed implementation support for the user. – Calendar function to remind the user of important management dates.	– Infothek has to be kept updated by the paying agencies → requires their cooperation.
	– Valuable benefit for the paying agencies by the facilitation of the monitoring process. – Data are saved on a central server and will be provided only to the paying agencies on demand.	– Thus far, no option to document measures that *have not* been undertaken in the field/grassland.
	– Farm data are safe due to different user levels within the app.	
Format	– Quick and easy to use on on-hand devices (smartphones/tablets). – Usable on Android and iOS devices. – Free of charge.	– Insufficient location accuracy, general dependence on internet access and connection → can become a challenge in remote rural areas.
	– The NatApp is designed as a modular system and, therefore, provides various expendabilities.	

Concerning the benefits for the paying agencies, we can conclude that EGNSS4CAP does provide almost the same documentation proof as NatApp. Although the documentation proof (geotagged pictures) is the same for both apps, EGNSS4CAP uses more advanced technologies (Galileo and Copernicus data). Nevertheless, not only by providing structured and comprehensive information, NatApp can open up new perspectives on AECM for all stakeholders involved and acting within the frame of the CAP. NatApp is developed in modular systems that can easily be extended to any new technology or requirement. In addition to AECM and new CAP, their use in nature conservation projects and contract systems would be a field of application for NatApp in the future. It was developed in close cooperation with the farmers and, therefore, also has the potential to be broadly accepted and facilitate the implementation of AECM among all participants.

However, NatApp also has limitations (Table 3). One, if not the most important, aspect is the acceptance of NatApp among the involved stakeholders, especially the paying agencies and the farmers. This part can be influenced, to a certain degree, by a user-oriented development as much as possible. Nevertheless, a certain level of uncertainty about the final application of NatApp will remain. In addition, digitization in agriculture is a rapidly developing field. The challenge of NatApp is to keep up with the latest technological developments as well as with political reforms. The CAP is a complex and agile framework among a great number of actors. Therefore, European guidelines are regularly adjusted and rebuilt. These developments have to be transferred to the Infothek, meaning that provided information needs to be maintained and kept updated by the providers of the measures, the paying agencies (Table 3). The use of sentinel data, as presented in the context of the EGNSS4CAP app in Table 1, which provide high-resolution images, is one example of progressing technologies. AI tools, remote sensing technologies, and other new features are constantly progressing. How can NatApp be classified in relation to these developments? How can the app keep up with these developments or even be combined with them? In addition to technical progress, the requirements are another dynamic and versatile domain, and the possibilities of automated processes in agriculture are steadily rising. These developments need to be integrated into NatApp to keep it as an up-to-date tool.

For a broader establishment of NatApp, it is important to consider that a great number of farmers already use various digital tools in their daily farming practice. Therefore, not only the simple applicability and the persuasive additional value of the Infothek for farmers but also the adaptability and possibilities to link NatApp to already existing tools used by farmers (for example, 365FarmNet or photo documentation in Agrarmonitor) remain to be demonstrated in the practical use of the app. For the broad implementation of a tool, it is necessary to provide the highest possible facilitation for farmers. This means using only a few main tools instead of a great number of different tools. Hence, interfaces of NatApp to other tools are of great importance.

NatApp cannot replace personal nature conservation consulting by trained staff. Individual cases need competent and on-site advice. What role will NatApp play against this background? NatApp supplies farmers with a good overview of available AECM. When information limits are reached, NatApp provides references for further information and assistance. However, NatApp is an easily accessible and free-of-charge tool that runs on both common iOS and Android software (Table 3). Sensitive farm data are safely acquired and stored.

NatApp has a role to play in contributing to the achievement of the Sustainable Development Goals (SDGs). SDG 2 ("Zero Hunger") aims to create a world with food security, improved nutrition, and sustainable agriculture [38]. With a broader implementation of AECM, farmers can actively collectively contribute to this SDG. Fostering biodiversity in agricultural landscapes strengthens the ecological balance of agrarian systems and, therefore, their resilience and capacity to adapt to a changing environment, such as under climate change. In the long term, resilient cultivation areas can ensure a more secure supply of food. Beyond that, agricultural landscapes with vital and sound ecological functions facilitate the preservation of genetic diversity of important wild plant and animal species. By encouraging a widespread realization of conservation measures and, thereby, halting the biodiversity loss, NatAPP contributes also to SDG 15 ("Life on Land").

6. Conclusions

NatApp has great potential to contribute to a broader and more efficient implementation of the environmental guidelines for agriculture within the CAP and, thereby, foster sustainable agriculture. Our analysis showed that the main focus of available digital farming tools is on precision and smart farming to reduce harmful inputs, but they offer limited support to find and implement site-specific conservation measures and, thus, improve the level of biodiversity in agricultural landscapes. Additionally, these tools are limited with regard to providing assistance for obtaining information on the specification of policy measures and simplifying the highly bureaucratic processes within the CAP for both farmers and the paying agencies. In contrast, NatApp aims to significantly reduce and facilitate bureaucratic effort within the programs of the CAP and especially the AECM for both farmers and paying agencies. Unique features, such as the Infothek, which offer a valuable structured source of information for farmers, have not yet been established in other digital tools available. As a mobile smartphone or tablet app, NatApp is an easy-to-use tool even in remote rural areas. Thereby, NatApp can stimulate the spread of information and communication technologies (ICT) in agriculture into outlying, lower structured areas and, due to its concept and target, enhance the agricultural and rural development there. However, it should be pointed out once again at this point, that our search was limited to the English-written literature and resources. Any tools published in the literature or developed in countries of a foreign language are not considered here.

Nevertheless, this study defines the necessity, as well as the unique features, of NatApp among other digital tools available. NatApp is not a general tool for farm management but provides tailored information for farmers and encourages nature conservation. To fully exploit the potential of NatApp and enhance its acceptance among farmers in the long run, the tool needs to be kept technically updated and display suitable interfaces with already established farming tools. In doing so, NatApp could significantly facilitate and optimize land management for farmers and the environment. In particular, the small-scale, field-integrated conservation measures, potentially incentivized via AECM and promoted by NatApp, are important instruments for strengthening biodiversity in agricultural landscapes. Although they are significantly more effective, they also require much more elaborate management compared with large-scale conservation measurements. In addition to publicly subsidized propositions, such as AECM or new designs of the CAP, such as Eco-Schemes, further use of NatApp can be considered. On the basis of its modular composition, NatApp can be adopted by various conservation programs and projects, such as Agora Natura or FInAL. For all conservation programs that need an information and monitoring tool, NatApp provides valuable support.

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