STØTTET AF
Mælkeafgiftsfonden

Cloud based precision feeding system (KIIP) for dairies integrated with the Danish herd management system and NorFor client DMS

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Introduction

Efficient use of feed resources is of paramount importance to the dairy industry and dairy farmers are facing numerous challenges related to feed use and resource utilization. Improved tools for feed budgeting, feed planning, production control, documentation of mass flow in the production and tools for optimization the very complex system is one of the strategies for the dairy industry to step up to the challenges. The dairy production system is characterized by many farm specific factors of which many also poses considerable day to day variation (i.e., dry matter and chemical composition of forages). Since late 19th century there has been dedicated considerable research and development resources into establishing feeding models/systems for the prediction of animal responses to dietary and environmental inputs. However, the prediction approach suffers from lack of feedback from the production and limited details describing system input i.e., feed analyses.

The following hypotheses were initiating the project:

- Important factors with impact on feeding value of forages cannot be analyzed with known analytical assays and research into the importance of factors like varieties of crops, weather, crop rotation, interactions between crop and processing during harvest, storage (ensiling) processes, silage bunker dimensions and interactions between feed and feeding equipment requires large scale data from many farms
- Many environmental, dietary and management factors that impacts cattle from fetus through the production life of the cow have yet to be quantitated
- In-line dry matter monitoring is fundamental to obtain higher feeding precision in a production system with bunker storage of forage posing variable composition
- Leftovers is a critical feedback for day-to-day optimization of feed allowance
- Environmental factors like barn temperature, humidity, light intensity, gas concentrations etc. are important predictors of feed intake and production
- Animal count and meta data for all animals in each group are important for calculating feed allowance per group
- Milk production per milking is useful to optimize feed allowance

The aim of the present study was to develop a cloud-based feeding system integrating feed planning, production feedbacks and dynamic recipe adjustments with an intuitive UI as a fundament for improved biological optimization of dairy production systems.

System components

KIIP is an add-on to existing SEGES applications and services. In Figure 1 the first two columns represent SEGES systems in operation before KIIP was initiated. FBO service holds a central position as the web service that gives access to feedstuffs, feed recipes, feed sections and enable storage of feeding data. The KIIP system has three main components: KIIP backend WEB API, KIIP feeding app, and the KIIP gateway. The KIIP gateway is connected to the physical feeding equipment i.e., feed mixers on load cells with or without NIR instruments for real-time analysis of dry matter and composition of mix.

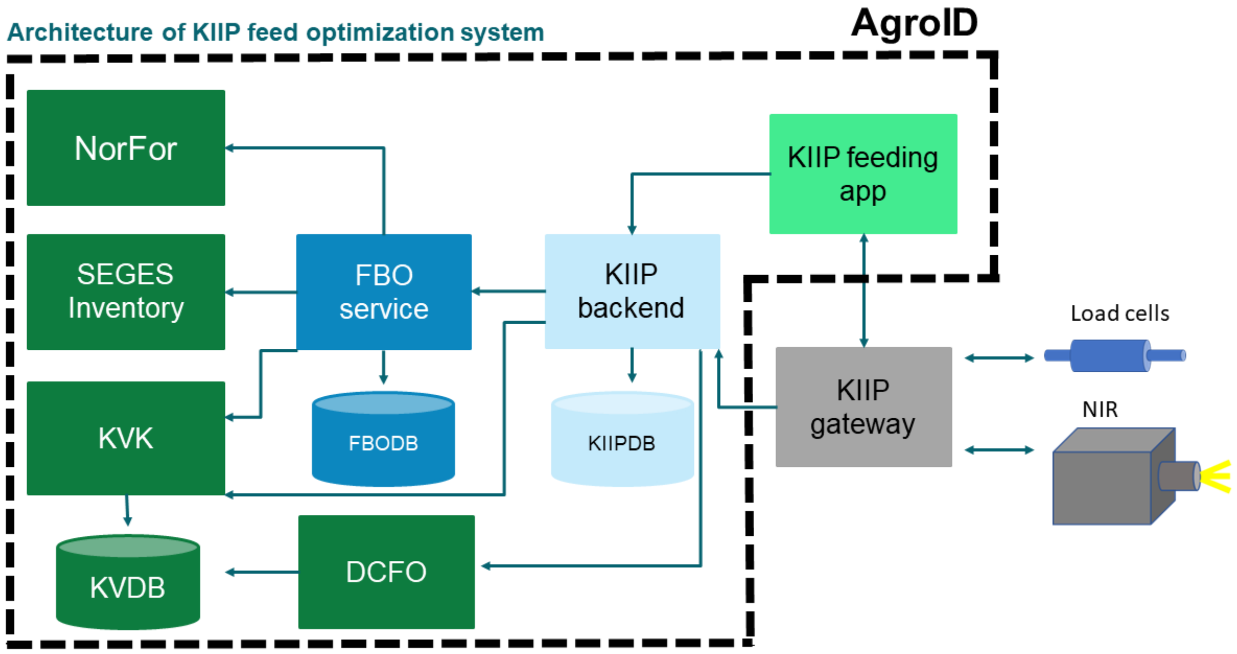


Figure 1. Schematic view of KIIP. Arrows indicate a call from an application or service.

KIIP backend WEB API

Authentication and authorization in KIIP API are performed by AgroID, an identity provider hosted by Seges Innovation, see https://www.seges.dk/da-dk/software/dlbrfaelleslogin for further information.

All controllers in KIIP API are secured by AgroID, i.e., a http authorization header containing a security token issued by AgroId must be present in alle http request to KIIP API.

After a successful login in AgroId, the client-side flow is as follows:

1. AgriBusinessController:
   Method: GetAgriBusinessByUpnName
   Http method: get

   Query parameter: upnName
   Return value: AgriBusinessEntity

2. FeedPlanController
   Method: UpdateFeedPlans (from DMS/FBO)
   Http method: put
   Query parameter: agriBusinessId
   Return value: a list of active FeedPlanEntity (DMS/FBO)

3. FeedPlanController
   Method: GetFeedPlanById
   Http method: get
   Query parameter: feedPlanId
   Return value: FeedPlanEntity

4. FeedPlanController
   Method: GetMixturePlan
   Http method: get
   Query parameter: feedPlanId
   Return value: CreatedIngredientMixture, SectionUnloads

5. MixController
   Method: CreateMix
   Http method: post
   Query parameter: agriBusinessId
   Body: ReceptMixRequest
   Return value: Mix, FeedPlanReceptEntity

6. MixItemController
   Method: CreateMixItem
   Http method: post
   Query parameter: feedPlanId
   Body: MixLoadEntity
   Return value: CreatedIngredientMixture, SectionUnloads

7. MixUnloadController
   Method: CreateMixUnLoad
   Http method: post
   Query parameter: agriBusinessId
   Body: MixUnloadEntity
   Return value: MixUnloadEntity

KIIP feeding app

The KIIP feeding app was built in Flutter. Authentication and authorization in KIIP app are performed by AgroID.

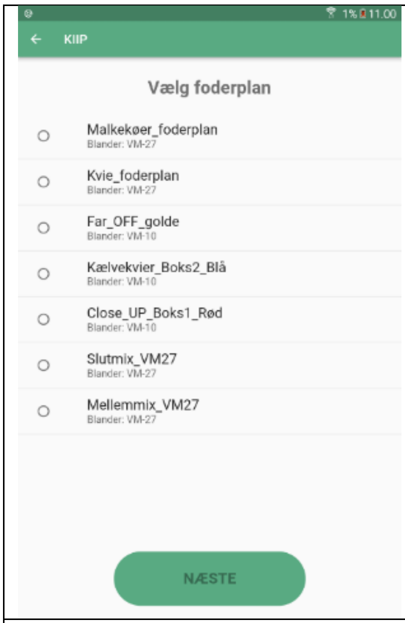
The KIIP feeding app is not a feed adjustment tool on the phone, the app is intended to control the loading, mixing, and unloading processes with highest possible precision and to ensure that irregularities, errors, and warnings can be logged efficiently. So far logging functions are not fully implemented.

The app has the following main functions:

Load

The feeding loop is initiated in NorFor with the formulation of a recipe containing the proportional dry matter composition of a feed mix, mix order and ingredient ID's. The operator is presented for ingredients (Figure 2), amounts to load, feed mixer mapped to recipe and planned unload to each attached feed section (Figure 3). When the user starts the mix a new unique mixID is created in FBO service and the user is guided through the load of each ingredient. On the load view the total weight of the mixer is displayed along with the total amount of current feedstuff to be loaded and the remaining amount of current feedstuff to be loaded. An indicator is showing the relative amount of current feedstuff loaded from 0 to 100 percent (Figure 4).

When the user activates "mix finished" a confirmation prompt is displayed (Figure 5, at present the user cannot step backwards in the recipe). If the mix has an associated mix time a timer will start (Figure 6) and must run out before the mix becomes ready for unload (no escape function implemented).



Vælg foderplan

○ Malkekøer_foderplan
Blander: VM-27

○ Kvie_foderplan
Blander: VM-27

○ Far_OFF_golde
Blander: VM-10

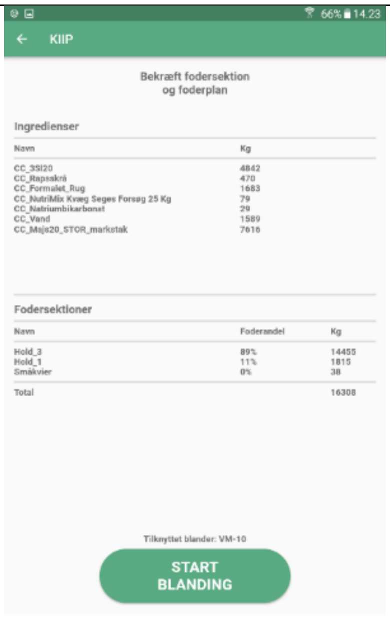
○ Kælvekvier_Boks2_Blå
Blander: VM-10

○ Close_UP_Boks1_Rød
Blander: VM-10

○ Slutmix_VM27
Blander: VM-27

○ Mellemmix_VM27
Blander: VM-27

Figure 2



Bekræft fodersektion
og foderplan

Ingredienser

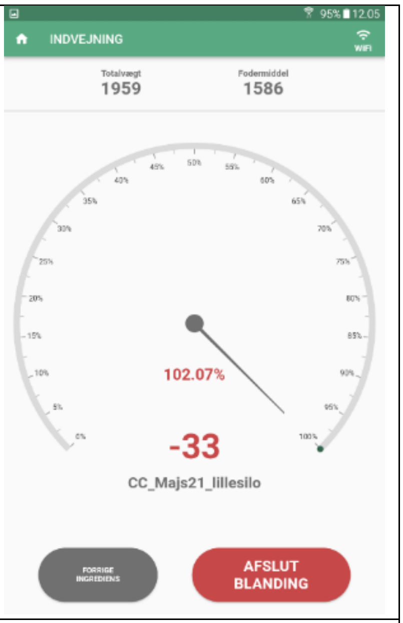
Navn	Kg
CC_3SI20	4842
CC_Rapsskrå	470
CC_Formalet_Rug	1683
CC_NutriMix Kvæg Seges Forsøg 25 Kg	79
CC_Natriumbikarbonat	29
CC_Vand	1589
CC_Majs20_STOR_markstak	7616

Fodersektioner

Navn	Foderandel	Kg
Hold_3	89%	14455
Hold_1	11%	1815
Småkvier	0%	38
Total		16308

Tilknyttet blander: VM-10

Figure 3



Totalvægt
1959

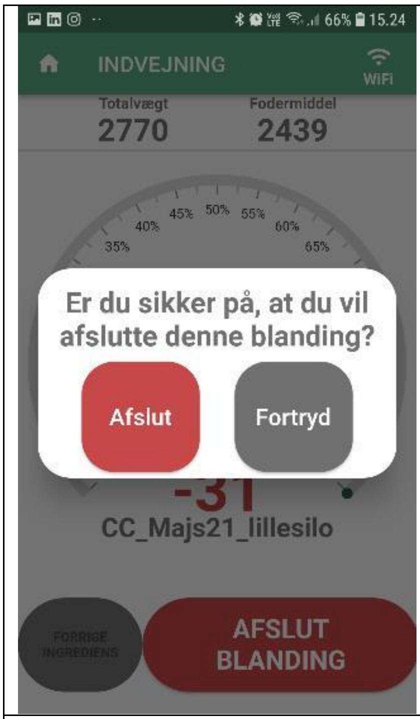
Fodermiddel
1586

102.07%

-33

CC_Majs21_lillesilo

Figure 4



Totalvægt 2770

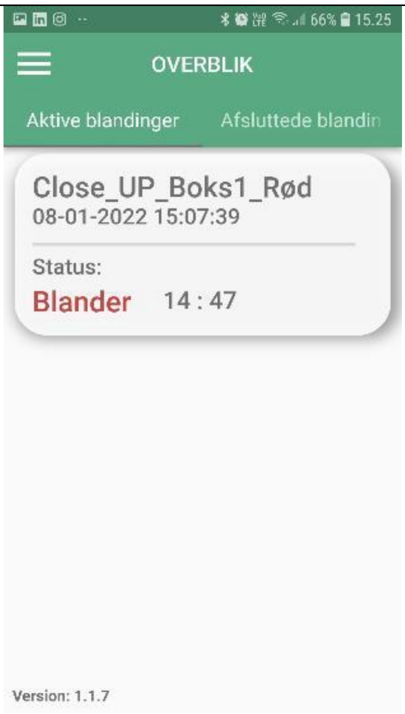
Fodermiddel 2439

Er du sikker på, at du vil afslutte denne blanding?

-31

CC_Majs21_lillesilo

Figure 5



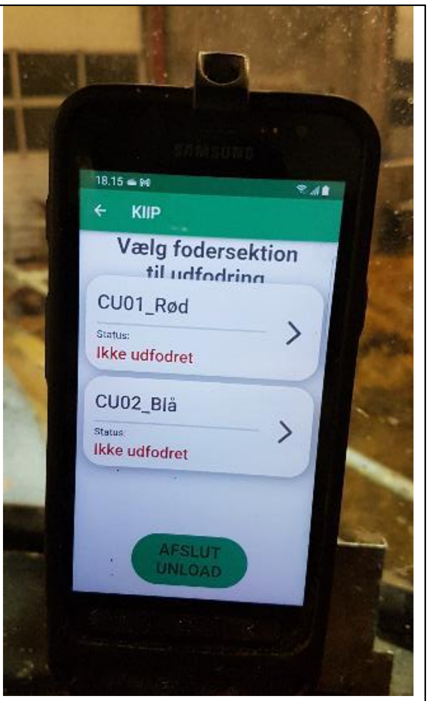
Close_UP_Boks1_Rød

08-01-2022 15:07:39

Status: Blander 14 : 47

Version: 1.1.7

Figure 6



Vælg fodersektion til udfodring

CU01_Rød
Status: Ikke udfodret

CU02_Blå
Status: Ikke udfodret

Figure 7

Unload

When the mix time for a mix is completed, the mix will be ready for unload. When activating the mix, feed sections associated with the mix is displayed (Figure 7) and the user must activate each feed section and will be guided to unload preplanned proportion of the actual load in the mixer to each of the feed sections. When unload is completed for each section, the flow is terminated by a call to KIIP backend API.

Leftovers

The traditional way of calculating feed intake for groups of cattle have been based on yesterday’s allowance minus today’s leftovers. At present the KIIP system hold unload information until feeding day +1 where it is possible to register leftovers and information of both unloads and leftovers for each feed section. Data is sent to FBO at 2000 h.

KIIP gateway

The KIIP gateway is build on Raspberry Pi 4, Cradle Point routers and power supplies. The project contains several Rust language projects designed to run on the Raspberry Pi. The Weight-reader and NIR-reader pushes data to the KIIP backend API and stream on local Wi-Fi according to criteria set in config files on the Pi. The NIR-server accept commands from the KIIP app to initiate reference scanning with the Perten NIR instrument and to change the product running on the NIR instrument. The auto-soft-shutdown project allow for controlled shutdown of NIR and Raspberry Pi dependent on ignition power.

Conclusion

The combination of an app developed in Flutter, a backend based on ASP.NET, a MSSQL database, and a gateway using a Raspberry Pi has proven to be a promising ecosystem for controlling the practical feeding operations and connecting practical feeding with system optimization and analysis.

Acknowledgements

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