Panazoo – Validation of Yield Sensor System for Cows

Validation Summary Report of ICAR Validation Test Findings

Overview of Test Purpose, Scope and Results

Category of Measurement(s)	Milk Yield (sampler not included)
Species & Life Stage	Dairy Cattle – lactating cows
Measuring principle	Electrical conductivity of milk in flow sensor
Level of Reporting	Individual Cow Yield Measurements at Each Milking
Use and Usability of Data	Management Data Only
Parameters Included in the Validation Test	Milk yield (10% accuracy claim)
Accuracy Results for bias	All 6 sensors within 10%

Definition of the measurement principle

- The Panazoo MMI sensor is designed to measure milk yields of individual cows milked in a milking parlour. The system has a setting for goats but results for goats were not part of this test.
- The device has a sensor measuring electrical conductivity of milk in a flow sensor while transferring the signal using algorithms into an estimated milk yield.
- The device is mounted in the milk tube between milk cluster and milk pipeline (low line) and has a control unit and interface for reading yield and cluster detachment of cluster.

Evaluation of the accuracy/repeatability/reproducibility of measuring component(s) of the system

- Overview of results of one farm with 6 devices comparing the sensor readings with the reference bucket on standard deviation, bias, regression, R^2, homoscedasticity and standard deviation for residual differences using ICAR statistical e-tool. Testing was done without sample testing.
- Due to the setup with farm testing with cows, calculations for repeatability are not available.

Parameter	Farm Spianez					
	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensors 6
Claim for accuracy on bias	*10%*	*10%*	*10%*	*10%*	*10%*	*10%*
# measurements	40	40	40	40	40	41
Range min-max (kg)	7.24-18.28	4.97-17.96	6.32-18.43	4.85-18.24	1.52-20.55	6.43-17.07
Average (kg)	11.47	11.30	12.03	11.37	12.54	11.46
Bias (kg)	-0.186	0.522	0.182	-0.139	-0.394	-0.633
Bias sensor_ref%	-1.65%	4.41%	1.49%	-1.24%	-3.32%	-5.85%
Significant	Yes	Yes	No	Yes	Yes	Yes
Regression line	2.755-0.256x	2.565-0.181x		1.721-0.164x	1.717-0.17x	2.113-0.24x
SD_Ref_Bias (kg)	1.5598	1.2949	1.2491	1,4239	1.0381	0.9341
SD_Ref_Bias %	13.59%	11.46%	10,38%	12.52%	8.47%	8.15%
Residuals R^2	-0.520	-0.352	-0.192	-0.326	-0.473	-0.738
Homoscedasticity	Yes	No	Yes	No	Yes	Yes
Standard Deviation for residual difference (kg)	1.560	0.740 / 1.483 / . /.	1.249	0.597 / 1.523 / . /.	1.044	0.934

Data derived from statistical analysis using ICAR e-tool

Besides statistical data, calculations were also made for Root Mean Square Prediction Error (RMSPE).

Yield (kg)	RMSPE at farm Spianez for milk yield was 11.25% with a coefficient of determination (R2) of 80%. This is considered a moderate magnitude for on-farm data management. Decomposition of the mean-squared prediction error indicates that random error (ED) accounts for 99.1% of the total, while mean bias (ECT) and slope deviation (ER) contribute 0.71% and 0.23%, respectively. This pattern shows that the sensor's predictions closely follow the reference relationship, with variability dominated by random dispersion rather than systematic error. Because the device infers yield from milk conductivity, cow-specific effects remain influential and should be considered in analysis and calibration. The model with cow effect included explained 92.5% of the variance with $R^2 = 0.925$.
Prediction accuracy	Overall, the Panazoo sensor tends to underestimate actual milk yields, particularly at higher values. The average underestimation is 4.3%. Despite this, the relationship between sensor predictions and reference measurements is strong and approximately linear. The regression slope is close to one, and the intercept is not significantly different from zero, indicating a consistent pattern across the range of values

Evaluation of the animal ID system and linkage to measurement

- The Test Centre did not face challenges with (in)correct ID values during the ICAR validation test.

Evaluation of the data handling – estimates, rounding, missing data points, and outliers

- The Panazoo Farm Management System produces accurate data for cow milkings containing Cow Number, Cow ID, milk yield (max 3 milkings a day), temperature and conductivity.
- Missing values are reported as no value.
- The Panazoo FMS can present data in several reports and graphs for farmer support.

Evaluation of the data interface & transfer procedures to MRO and databases

- Although the Panazoo offers transfer of data, due to absence of certified sensors and samplers, this part could not be evaluated.

Evaluation of the system installation parameters and procedures

- The Panazoo MMI sensor and other related devices have to be installed by the supplier.
- The device is mounted in the long milk tube between milk cluster and (low) milk line.
- The software of the sensor is stand alone, however can be connected with the FMS of Panazoo.

Evaluation of the routine or periodic checking procedures

- The routine or periodic checking procedure was evaluated based on the procedures provided by the manufacturer/applicant. Also these procedures are working straightforward fitting with the purpose of the Panazoo sensor.
- Routine procedures for the other versions based on the MMI sensor are identical..

Evaluation of the effect of the system on animal well-being

- There is no direct effect of the system on animal well-being is expected for this device.

Compliance of other devices based on the Panazoo MMI sensor

- Panazoo provided a list of 18 other devices used by different manufacturers, two of them are dedicated to goat/sheep milking.
- The devices are based upon the same technology and principles as used in the original Panazoo indicator MMI that was used in the field tests. It was concluded that all those devices are similar regarding the measuring principle, algorithms and documentation available.
- Installation and routine procedures are equal.

Overview indicators based on MMI model

#	Name Indicator	Manufacturer / supplier
1	MMI BASIC	
2	MMI+	
3	GLOBAL IDS	
4	MMI+ LED	
5	MMX+LED	
6	MMCOMPACT Plus	
7	GMI+	BouMatic
8	SOFFIMAT PLUS	BouMatic
9	SOFFIMAT PLUS FREEFLOW	BouMatic
12	MM1	Happel System Gmbh
13	MMI+	DairyMaster
14	ARMEKTRON MMI+	Milkplan
15	ARMEKTRON MMI+LED	Milkplan
18	IMILK 401	Milkrite Interpuls

Plots Panazoo MMI sensors at farm Spianez