Water use assessment

of livestock production systems and supply chains

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Water Footprint Analysis of Milk Processing Industry: A Case Study of Punjab (India)





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Milkfed Punjab (India)

Outline of Presentation

- Introduction
- Methodology
- Findings
 - ✓ Water Footprint Calculations
 - ✓ Seasonal Analysis
 - ✓ Product- Mix Analysis
 - ✓ Assessment for Water Usage
 - ✓ Projections
- Recommendations

Introduction

≈ 79 % of Punjab lies in overly exploited zone

Contributes 6.4% to the national milk production with only 2.2% of the total bovine population





Highest Milk Producer but \approx 54% of area is under high water stress

Milk Processing Sector in Punjab



In developed nations 90% of milk enters organised commercial channels

A glimpse of Groundwater Availability & Utilization Pattern in Punjab

Net groundwater availability (BCM)	21.58
Annual groundwater draft (BCM)	35.78
Crop Sector (%)	96.59
Domestic and Industrial Usage(%)	3.41
Stage of groundwater development (%)	166
Extent of overuse of groundwater(BCM)	14.20

(CGWB (2017))

Uniqueness of this case study

1st attempt in South Asia to analyze the Water Footprint (WF) of Milk Processing in Dairy Plants

Assessment of the Indirect Water Footprint (IWF) in the Milk Processing

Region specific focus on water availability & utilization in the State (Punjab)

Only study where time series data of five years has been analyzed

Methodology

Milk Plants



Observations Recorded

- Time Series Data (2015-19)
- Seasonal Milk Procurement
 - ✓ Lean Season (Apr to Oct)
 - ✓ Flush Season (Nov to March)
- Seasonal Product Mix
 - ✓ Liquid Milk
 - ✓ Dahi
 - ✓ Ghee
 - ✓ Butter
 - ✓ Paneer
 - ✓ Milk Powder
 - ✓ Ice Cream
 - ✓ Milk Cake
- Monthly Water and Energy Usage

Details of Selected Milk Plants in Punjab

Plants	Installed Capacity (Million L/day)	Utilized Capacity (Million L/day)	% Utilisation
X1	0.55	0.60	109.09
X2	0.40	0.47	118.00
Х3	0.20	0.23	112.50
X4	0.25	0.30	120.00
X5	0.75	0.80	106.67
X6	0.13	0.15	115.38
Х7	0.10	0.10	100.00
X8	0.13	0.15	115.38
X9	0.15	0.20	133.33

Flow of Water at Milk Processing Plants



Water Footprint Calculation

(L water used in per kg of milk processed)

Direct Water Usage (DWU) :

Water Usage Milk Processed

Indirect Water Footprint*(IWF): Water consumed in generation of electricity Milk Processed

Direct Water Footprint (DWF) : <u>Water Consumed in Proces</u>sing Milk Processed

Total Water Footprint (TWF) : Direct Water Footprint + Indirect Water Footprint

- 26 % of the total electricity is generated through Hydro power while rest is generated through thermal power
 (Statistical Abstract of Punjab, 2020)
- In coal based power plants, consumptive water usage is 5000 litre/h/MW (CEA, 2012)
- The water footprint for electricity generation at Hydro power is 9221.44 litres/GJ

Plant wise Water Footprint

Parameters	X1	X2	Х3	X4	X5	X6	Х7	X8	X9	Average
DWU	1.79	1.90	2.52	2.04	1.82	7.02	5.10	5.43	2.15	3.31
DWF	0.48	0.47	0.56	0.65	0.40	1.76	1.96	1.78	0.47	0.95
IWF	4.81	6.94	6.58	7.66	4.99	10.39	12.28	8.42	10.30	8.04
TWF	5.28	7.41	7.14	8.31	5.39	12.14	14.23	10.20	10.78	8.99

- DWF comprises 10.57 % while, remaining 89.43% comprises of IWF
- Variation in water consumption in per kg of milk processed was best explained in large plants
- Energy consumption had major impact on water utilization in milk processing at dairy plants

Major Water Consumption Areas



Reconstitution Tank

Tanker Cleaning



Other Water Consumption Area and Effluent Tank



Packaging line

Effluent Tank



Comparison of WF with other Countries

Countries	Product Mix	L Water per kg of milk processed	Source
Punjab (India)	Liquid Milk, Ghee, Butter, Paneer, Milk Powder, Ice Cream, Dahi, Milk Cake	0.40-1.96 (TWF =8.99±3.06)	
Australia	Processed Liquid Milk	1.05-2.21	Prasad et al,2004
Canada	Milk, Butter, Cheese	1.0-5.0	Wardrop Eng Inc.,1997
Denmark	Milk and Dairy Drinks	2.21-9.44	Bosworth et al, 2000
Poland	Processed Milk, Dairy Drinks, Cream, Cottage Cheese, Butter , Milk Powder	3.48-9.77	Wojdalski et al, 2012
France	N.A.	0.20-10.00	Vourch et al, 2008
Sweden	Milk ,Dairy Drinks and Whey Products	0.96-4.00	WS Atkins Polska, 2005
Finland	Cheese and Whey Products	1.20-4.60	WS Atkins Polska, 2005
Norway	Milk, Milk Powder, Cheese and Dairy Drinks	2.05-6.30	WS Atkins Polska, 2005

Seasonal WF vis-á-vis Milk Processed



Product-Mix vis-á-vis TWF

—Milk Proc (Million Kg) — Liquid Milk (%) — Milk Products (%)



Plant wise Composition of Liquid Milk & Milk Products (%)

Plant	Milk Proc (Mill kg)	TWF*	Liquid Milk (%)	Ghee (%)	Butter (%)	Milk Powder (%)	Paneer (%)	Dahi (%)	Milk Cake (%)	lce cream (%)
X1	15.86	5.28	87.07	1.61	2.58	3.43	0.80	4.51	0.01	
X2	4.68	7.41	93.15	0.99	0.84	0.07	1.02	3.92		
X3	3.34	7.14	90.78	0.77	0.83	0.00	0.54	7.08		
X4	3.62	8.31	90.38	0.98	1.04	2.72	1.02	3.90		
X5	18.14	5.39	88.93	0.41	1.11	0.00	1.08	8.46		
X6	2.45	12.14	76.28	3.49	2.10	3.90	6.70	7.14		0.38
Х7	1.34	14.23	85.19	1.33	2.05	2.74	0.93	7.76		
X8	2.51	10.20	56.20	8.31	5.29	12.20	7.52	10.47		
X9	1.96	10.78	85.95	1.97	2.55	5.76	0.46	3.32		
Average	53.90	8.99	83.77	2.21	2.04	3.42	2.23	6.29	0.01	0.38

*Litre water used in per kg of milk processed

Principal Component Analysis(PCA) of Milk Products

Variable	PC1	PC2
Liquid Milk	-0.95	-0.29
MP	0.91	-0.19
Butter	0.78	-0.29
Ghee	0.73	0.27
Dahi	0.24	0.71
Paneer	0.61	0.66
Milk Cake		-0.39
Icecream		0.58

Liquid Milk, Milk Powder, Butter, Ghee and Dahi the major contributor to WF

Assessment of Water Usage in Selected Milk Plants

Plants	Ground Water Over Utilization (%)	Total Water Usage (TWU) at Industrial and Domestic Level (MCM)	Total Water Usage (TWU) in Milk Plants (MCM)	Consumptive Water Usage (CWU)in Milk Plants (MCM)	Effluent Water Generated (MCM)	
X1	182.94	163.3	1.46	0.39	1.07	
X2	239.16	122.64	0.47	0.12	0.35	
X3	216.82	71.39	0.45	0.10	0.35	
X4	147.61	100.14	0.39	0.13	0.26	
X5	119.50	71.77	1.06	0.23	0.82	
X6	97.54	54.84	0.88	0.22	0.66	
X7	107.20	72.31	0.30	0.09	0.20	
X8	260.00	61.29	0.72	0.24	0.48	
X9	134.24	70.64	0.13	0.03	0.10	
Punjab	165.80	1217.72	5.85	1.54	4.31	
CW	/U: 0.13 %	TWU: 0	.48 %	Proj. TWU (Punjab): 2.27 %		

Source: Worked out from Ground Water Resources of Punjab State, 2017 and Own Calculations

Water Usage in Milk Processing Plant Projections



Conclusion and Policy Recommendations

- TWF Processed milk = 8.99 L/kg
- ✤ 90% of TWF is contributed by IWF
- Dried Milk Plants had higher WF
- Dairy plant wise product profile needs to be rationalized
- ✤ 73% of TWU goes to ETP as effluent
- Need to recycle dairy plant effluent into various activities like Milk Tanker and Floor cleaning etc.
- Organized sector share in milk procurement is bound to increase therefore, water usage projections are the need of the hour



Thank you for your attention !