Setting more meaningful water targets: Towards more water sustainable banana production in Zona Bananera, Colombia

Technical Document

Frio river, Zona Bananera, Colombia
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Erika Zarate Torres[1]
Maite Martinez Aldaya[2]
Gabriela Parada[3]

[1, 3] *Good Stuff International. Contact: erika@goodstuffinternational.com. www.goodstuffinternational.com*
[2] *Independent consultant associated to Good Stuff International.*

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Executive summary

This report describes the practical insights gathered from the application of a methodology that seeks to use the current context of a basin as the basis for setting more actionable and realistic water targets. This methodology is illustrated using a Colombian banana farmer which is part of the supply chain of the German supermarket chain Edeka. While the start of this work pre-dates some of the emerging global conversations with respect to Context-/Science-Based Targets for Water – there are some lessons that could be beneficial contributions to the methodology development of Context-/Science-Based Targets for Water.

Introduction

This pilot study on water target setting has been developed in the frame of the WWF Germany - Edeka collaboration to increase the sustainability of Edeka's supply chain. WWF Germany has identified and studied the main water risks of production in Edeka's supply chain sourcing locations. One of the key identified regions is Zona Bananera in the North of Colombia. The focus of this paper is on banana production by Edeka's banana supplier in this region.

Since 2015, WWF Germany and WWF Colombia have been working to improve agricultural practices directly with 13 of the supplier's banana farms in Colombia. Complementing this work, Good Stuff International (GSI) analysed the water risks and opportunities for banana production in the two basins where banana farms are located: Frio and Sevilla rivers (figure 1). One of the main actions proposed, and subsequently implemented, was the creation of a local multi-stakeholder Water Stewardship Platform, which has been active since 2015 and has produced concrete achievements for the benefit of people and ecosystems.

Based on the comprehensive knowledge of these basins and shared water uses, as well as the structure in place facilitating dialogue and exchange (the Platform), WWF contracted GSI to pilot test an approach to support the banana supplier in developing more meaningful quantitative water targets that better account for the surrounding basin context where its farms operate. The purpose of this paper is to show in practical terms how these water targets were developed, the data required, the data gaps and main learnings. This paper is offered to companies, retailers and those contributing to the emerging methodological development for Context-/Science-Based Targets for Water.

In the context of this report, water targets refer to short, mid and long-term water goals that can be set in quantitative terms by an agricultural company, aiming at reducing water use at the farm level[1]. The aim is offer practical guidance to agricultural suppliers in how they can use their surrounding basin context to set more meaningful farm level water targets.

The Zona Bananera

The banana supplier has its farms located within the Frio and Sevilla basins in the region known as Zona Bananera of the Magdalena Department, in Northern Colombia (Figure 1). Frio and Sevilla basins cover an area of 1534 km^2 and are part of the Cienaga Grande de Santa Marta hydrographic area, one of the 316 hydrographic areas of the country.

Frio and Sevilla rivers originate in Sierra Nevada de Santa Marta (a mountainous complex that constitutes the water tower of the region), and flow into the Cienaga Grande (Colombia's biggest coastal lagoon and Ramsar site), along 63 km and 87 km respectively.

[1] Here we refer to «water use» in general terms. It encompasses water withdrawals, but also blue and green water consumption.

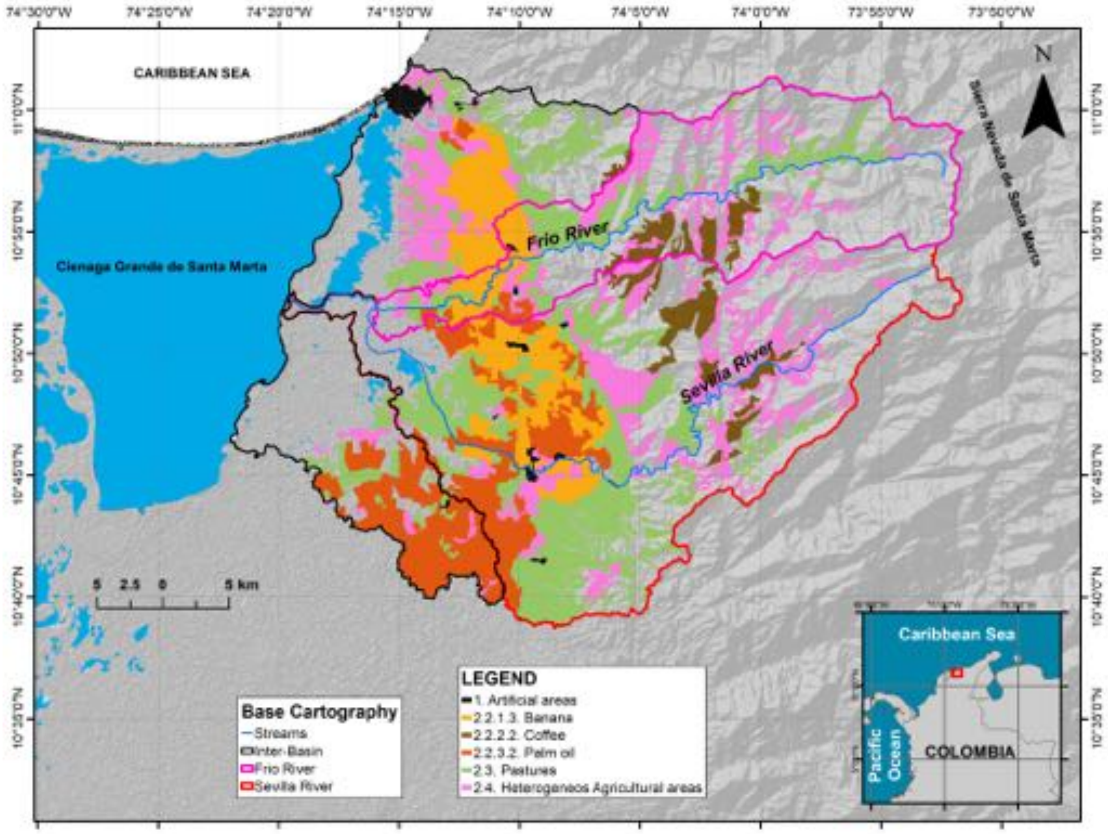


Figure 1. Land use map showing the Frio and Sevilla river basins, the Cienaga Grande de Santa Marta wetland, and the banana and palm regions.

The basins have an average annual precipitation of 1686 mm (average between 2000-2018[i]), with strong differences in its spatial and temporal distribution. Precipitation is higher in the Sierrra Nevada region and decreases as it approaches the coast. Additionally, there is a marked dry season from January to May (Figure 2). The base year for this study was 2017, with an average precipitation of 1626mm, considered as a good climatic year by the banana farmers, with optimum yields.

On their way through the plains (Zona Bananera) the rivers supply water for agriculture, the main economic activity of the region. Banana/plantain and palm oil production are the main water users. Other important crops include rainfed coffee and fruit trees with very low water use. An overview of crop areas is presented in Figure 1, and detailed areas of the two main crops, banana and palm oil, are presented in Table 1.

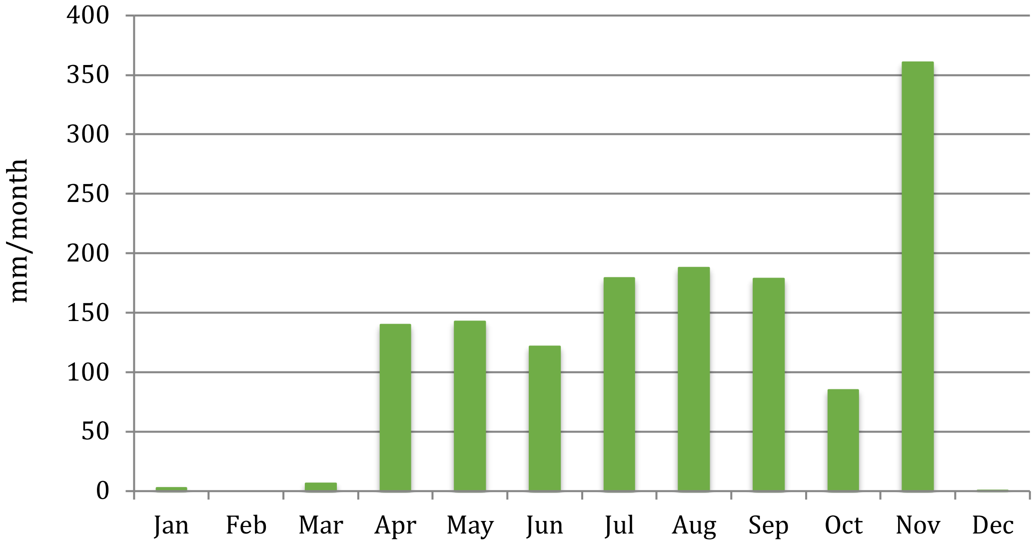


Figure 2. Cumulative monthly precipitation from the supplier's weather station, year 2017.[ii] Total Precipitation in 2017 = 1404 mm.

Water supply source	Concession	Plantain and banana[iii] (ha)	Palm oil[vii] (ha)
Frio river	In the Asoriofrio area of influence[iv]	4,256	974
	In the Canal Santa Inés area of influence[v]	870	1,400
Sevilla river	In the Asosevilla area of influence[vi]	5,280	3,482
Transfer from the Tucurinca river (Inter-Basin, Figure 2)	In the Asotucurinca area of influence[vii]	505	8,598
	TOTAL: 25,365 ha	10,911	14,454

Table 1. Distribution of banana and palm tree areas in relation to the irrigation districts jurisdiction (Asoriofio, Canal Santa Ines, Asosevilla, Asotucurinca) and their source of water supply in the 2906-02 basin (official sub-basin number), Frio and Sevilla rivers (hectares).

There are three main irrigation associations in the region: Asoriofrio, Asosevilla and Asotucurinca[2]. The first two allocate the water from the rivers Frio and Sevilla to the different agricultural uses and oversee that the concession (legal allocation), as determined by the regional government, is respected. The regional government (CORPAMAG) allocates and manages some concessions directly. Both Frio and Sevilla rivers are subject to a future basin management plan, indicating the local interest in improving water management in the region.

In order to set quantitative freshwater targets for the banana supplier, it was necessary to understand water flows at the farm level. For this, data for the 13 banana farms in the WWF project were collected. The 13 farms are within the Frio and Sevilla river basins with irrigation water supplied from them (Table 2).

The 13 banana farms represent 6% of the total agricultural area (plantain, banana and palm oil) within the river basins, 1,451 ha compared to 25,364 ha (Tables 1 and 2).

[2] Asotucurinca allocates water from the river Tucurinca, located outside of the area of interest and providing water through a water transfer to the "Inter-Basin" area in the south of the Sevilla basin (Figure 2).

Banana farms	Total area (ha)	Area in production (ha)	Water supply source	Concession	Water intake
Farms 1, 2	297	253	Frio river	Concession - CORPAMAG	Direct
Farms 3, 4, 7, 8, 10, 11	692	664	Frio river	Asoriofrio	District
Farm 6, 13	196	180	Frio river	Asoriofrio	Direct
Farm 5, 9, 12	266	247	Sevilla river	Asosevilla	District
Total	1,451	1,344			

Table 2. Area, source of surface water supply and concession for the 13 banana farms.

Methodology

The scope of this water target work addressed surface water in quantitative terms, building on the results of the water risks and opportunities study conducted in 2015. In this study, water scarcity was determined as one of the major water risks facing the region. The fundamental premise in the context of setting water targets for the banana supplier is that any quantitative water target should be framed in the context of mitigating water scarcity in the basins, and it should be possible to quantitatively link the water targets proposed to the basin situation.

For this, it was required to define monthly surface water sustainability boundaries for the basins, and to estimate the theoretical reduction of water withdrawals from the rivers required to remain within the agreed water sustainability boundaries. At the same time, it was required to produce complete farm water balances, in order to quantify the reduction potential of farm blue water use. Finally, the links between farm, banana supplier, banana sector and basins were established, in terms of blue water use.

The base year of the study was the calendar year 2017, using a monthly resolution.

In order to validate the methodology and data used, as well as to agree on assumptions, for results validation and to make the proposed water targets as concrete and realistic as possible, a local banana-sector working group was created and consulted throughout the development of this pilot study.

A simplified flow diagram of the practical steps followed to develop the water targets for the supplier is presented in Figure 3[viii]. The next sub-sections described the steps with more detail.

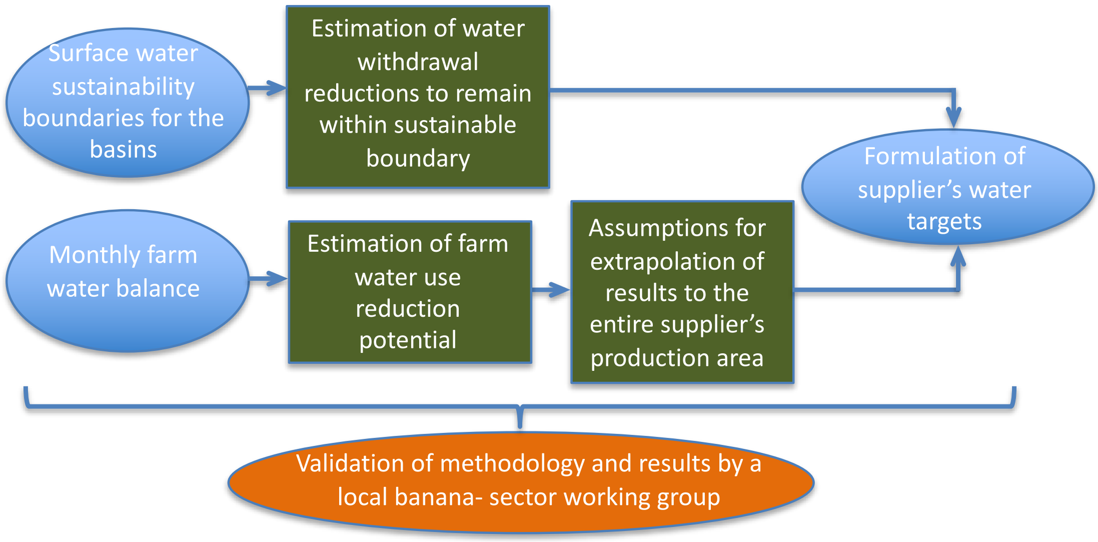


Figure 3. Flow diagram of GSI's water target setting methodology.

Sustainable basin boundaries

For setting the sustainability boundary of surface water in the Frio and Sevilla basins, the Water Use Index IUA (for its acronym in Spanish), as defined by the national authority, was taken into account. IUA is defined as the ratio between the water withdrawals and water availability, taking into account environmental flow requirements. This is the index used for assessing the water stress at the basin level in Colombia by the National Environmental Institution IDEAM[ix] and equivalent to the SDG Indicator 6.4.2. Since IUA is commonly used by hydrology experts in the country and is well documented in the national water publications, it was "easy" for the banana working group to understand and take IUA up as a measure of the sustainability boundary of the basins. GSI's work consisted in estimating IUA specifically for Frio and Sevilla basins at a monthly level, using local data.

When IUA is equal to 1, water withdrawals are equal to the maximum amount of water that can be abstracted from the river without compromising environmental flow requirements. An IUA value of 1 was defined as the sustainability boundary of the basin. This means that if IUA is bigger than 1 for any month, blue water withdrawals are not sustainable.

By assuming an IUA value of 1 for every month, it is possible to calculate the maximum monthly surface water withdrawal that are sustainable.

Farm water balances

Farm water balances[3] for the 13 farms in the WWF project were produced using the Geographic Agricultural Water Footprint Calculator (GAWFC)[x], which conducts a daily water balance in the soil based on five input files: daily precipitation, daily reference evapotranspiration, daily irrigation, soil and crop data. These data were collected for each of the 13 farms. The individual performance of the 13 farms in terms of actual irrigation, quantity and frequency, and optimal irrigation, was assessed and compared at a monthly basis to identify potential improvements on water use without affecting the yields. With a good understanding of the water balance for the 13 farms and taking into account additional information provided by the supplier, as well as assumptions agreed with the banana working group, the results were extrapolated to the entire supplier's acreage in the two basins.

[3] A farm water balance is based on the principles of mass conservation and is defined as the balance of inflows (precipitation, irrigation) and outflows (evapotranspiration, runoff and deep percolation) with respect to net changes in storage (water stored in the soil) happening inside the farm for a given time unit. Typical applications of the farm water balance include the development of irrigation schedules, the evaluation of irrigation practices, as well as rainfed production and drought effects.

Two scenarios were assessed for each farm: 1) the irrigation scheduling scenario, which assumes that the crop is provided all the water it requires for optimal growth, and 2) the base case scenario, which uses actual daily irrigation data.

Setting water targets

The farm water balances and the basins' IUAs were jointly analysed to understand the spatial and temporal linkages and effects, and develop results and entry points for target setting and action planning. On the basis of the critical months and locations identified in the basin, as well as the farm water use reduction potential analysis, a realistic reduction in the irrigation water demand was proposed for the base year, as the main blue water target for the banana supplier. Furthermore, going beyond the supplier to the entire banana and palm sectors operating in Frio and Sevilla, general targets were proposed for each sector. This last part of the exercise, although theoretical (no palm producers were included in the working group), was important as a frame to start quantifying the potential agricultural water use reduction in the basins based on the current agricultural land use maps, and the potential impact on the basins' water scarcity situation.

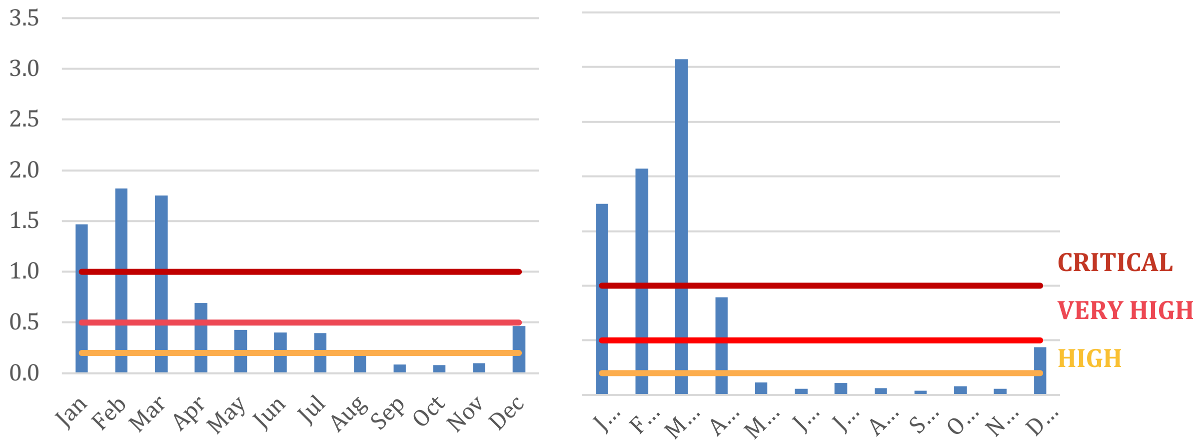
Results

Sustainable basin boundaries: Water Use Index (IUA)

The Water Use Index (IUA) in the Frio and Sevilla basins exceeds the value of 1 in January, February and March. This means that the basins have a pronounced dry period and critical water demand to water availability ratios in the first three months of the year (Figures 4 and 5).

In order to move to a more sustainable water balance it will be required to reduce the collective demand[4] to reach IUA values of 1 within this period of time, which would match the demand and available water. In order to achieve this, the demands (withdrawals) should be reduced from January to March by 3.85; 5.20 and 5.37 Million m^3 in the Frio basin and by 5.56; 6.93 and 9.52 Million m^3 in the Sevilla basin, respectively. This would mean reducing the collective demand by approximately 42% in the Frio river and by 54% in the Sevilla river, in the first three months of the year.

Additionally, in the case of the Sevilla river basin, the demand in March exceeds the total supply by 2.68 Million m^3. This means that the river would be dry. Therefore, the IUA of 3.08 in March is not possible; this demand must be met by groundwater sources. There are still important information gaps, especially regarding where the banana and palm take their water from in the dry season, at the beginning of the year. It is known that groundwater is abstracted, but it is not documented and therefore its quantity is unknown.



Figures 4 and 5. Average monthly Water Use Index (IUA) in the Frio river basin (left) and in the Sevilla river basin (right). Supply based on monthly average values 1978-2015. Demand based on the available concessions of agricultural water, established by the local authority.

[4] As mentioned in a previous section, agriculture is the main water use in the basins, with no presence of the industrial sector and poor coverage of domestic demands.

Farm water balances

Crop water stress levels: Actual water use versus crop water requirement

The water deficit is defined as the difference between the total theoretical crop water requirement and the actual total water use of the crop – including both green and blue water. In the case of banana, the highest the water deficit, the highest the levels of crop water stress[5]. A comparison of the irrigation scheduling scenario (assuming the crop is provided all the water it requires for optimal growth) and the base case scenario (using actual daily irrigation data) shows that water deficits vary widely among the 13 farms assessed.

In general, most farms experience some degree of water stress at the beginning of the year. Farms 5 and 11 present the highest water deficits, with 1,475 m^3/ha and 1,221 m^3/ha respectively (figure 6, table 3). Farms 1, 3 and 4 have an actual water use very close to the total water requirement, showing a minimal water deficit.

The crop water stress[xi] analysis shows that Farms 5, 9 and 11 experience crop water stress during the dry season, the first 100 days of the year (from January to March) through a K_s lower than 1 for more than 60% of the time (when *Ks* is equal to 1, there is no crop water stress). The *Ks* variation throughout the year for Farm 5 is shown in figure 7.

Farm	Annual deficit [m^3/ha]	Estimated crop water stress - 100days*	Net irrigation [m^3/ha/yr] (Sprinkler)	Estimated annual losses [m^3/ha/yr)	Estimated losses 100days** [m^3/ha]	Yield [t/ha/yr]
Farm 1	18	No	11,068	2,774	1,983	55.9
Farm 2	326	No	8,113	566	536	54.1
Farm 3	17	No	11,038	2,160	1,207	57.4
Farm 4	22	No	10,276	1,856	1,348	56.8
Farm 5	1,475	Yes (88 days)	4,180	36	-	56.5
Farm 6	481	No	5,920	64	115	52.2
Farm 7	352	No	8,291	956	595	56.0
Farm 8	475	No	5,983	387	334	51.0
Farm 9	610	Yes (63 days)	5,638	53	-	54.4
Farm 10	97	No	7,639	496	453	51.3
Farm 11	1,221	Yes (74 days)	4,773	101	41	53.6
Farm 12	66	No	10,197	2,972	2,568	53.6
Farm 13	252	No	9,307	1,924	1,807	63.4

Table 3. Total water deficit, net irrigation, estimated irrigation losses and yields for the 13 banana supplying farms (total annual and the first 100 days of 2017).

**Indicative of stress a Ks <1 more than 15% of the first 100 days of the year.*
*** Weighted losses per farm for the first 100 days of the year.*

[5] Crop water stress is represented by the factor *Ks*. This is a dimensionless factor of evapotranspiration reduction that depends on the amount of water available in the soil.

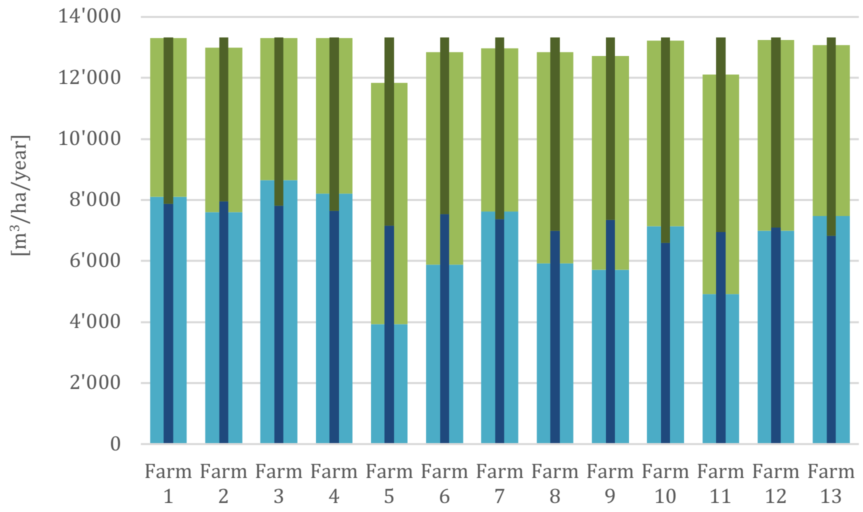


Figure 6. Annual blue and green water use and crop water requirement in the 13 banana plantations. Note: thin bars represent the irrigation scheduling scenario, and thick bars the actual water consumption.

When comparing Farms 5 and 1, Farm 5 presents water stress conditions at the beginning of the year, while Farm 1 does not show any stress. Both farms have very similar yields of 56 t/ha, which indicates that the yield in Farm 5 was not affected despite the water stress presented at the beginning of the year. Even if crop yields depend on a number of factors beyond water volumes, such as agricultural practices and soil quality, Farm 5 seems to tolerate a certain degree of stress without compromising its yield.

On the other hand, farms 5 and 12 are located close to each other and near a forest area with a high water table, sharing the same soil characteristics. However, the irrigation application in Farm 12 is 2.4 times greater than that of Farm 5. Based on these results, it is then possible to conclude that in Farm 12 the irrigation application can be reduced to a level similar to Farm 5.

This comparison among farms provide more insight into potential actions that could be taken at the farm level to reduce water use (irrigations) without compromising yields, and therefore leaving the water for the rivers and increasing the odds of operating within the predefined basin sustainability boundary for surface water.

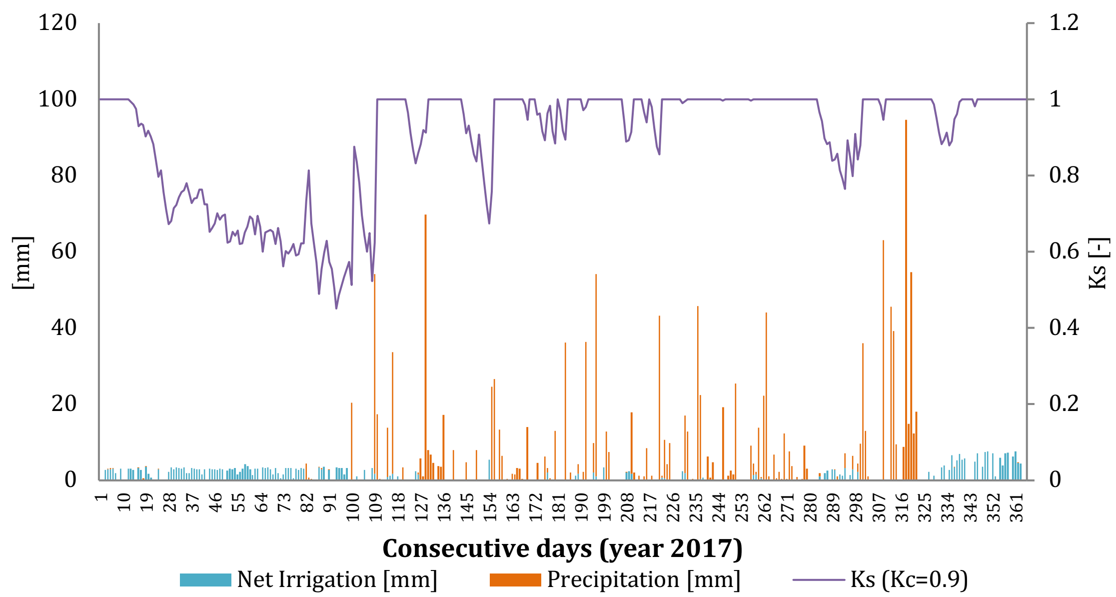


Figure 7. Irrigation application, precipitation and water stress level (Ks) for the year 2017 – Farm 5.

Water footprint and estimated water losses

By assessing farm water footprints and estimated farm water losses, it is possible to clearly identify the best performances in terms of farm water use, incorporating the yield in the analysis. In the context of setting water targets for the supplier, yields must be incorporated in the analysis, because water use can be reduced up to a point where it is not possible to reduce anymore without affecting profitability. This is key information for an agricultural company interested in realistically setting water reduction targets at the farm level. The intuitive goal of the company would be to increase yield while using the minimum possible amount of water. If it is possible to reduce withdrawals without compromising yields, the difference in withdrawal may remain in the rivers and therefore contribute to alleviate the basin's water stress (reduce IUA).

Farms 5, 6, 9 and 11 (a total of 481 hectares in production) are very efficient in terms of water use: they present the lowest blue water footprints (cubic metres per ton of product) and the lowest losses in irrigation application (figure 8 and table 3, respectively).

Farms 1, 3, 4, 12 y 13 (a total of 482 hectares in production) present the greatest optimization potential, with an average to up to 31% of potential irrigation reduction the first 100 days of the year. This percentage of reduction is estimated based on the water losses analysis. These farms are suggested to be prioritized for the reduction in irrigation application.

The optimization of irrigation depends as well on the type of soil predominant in the farm. There are soil textural classes that allow for greater water storage and deeper root development, which means greater water availability for the plants. For instance, the dominant textural class in Farm 1 is class III (low soil water holding capacity and shallow root depth), which implies that Farm 1 should have more frequent irrigations with lower water depth, otherwise the losses would increase as the irrigation that can retain the soil is small. Most farms have a mixture of textural classes II and III in different proportions. Just in Farms 5, 8 and 12 predominate the textural class II, which has a greater soil water holding capacity (119 mm/m) than class III (100 mm/m).

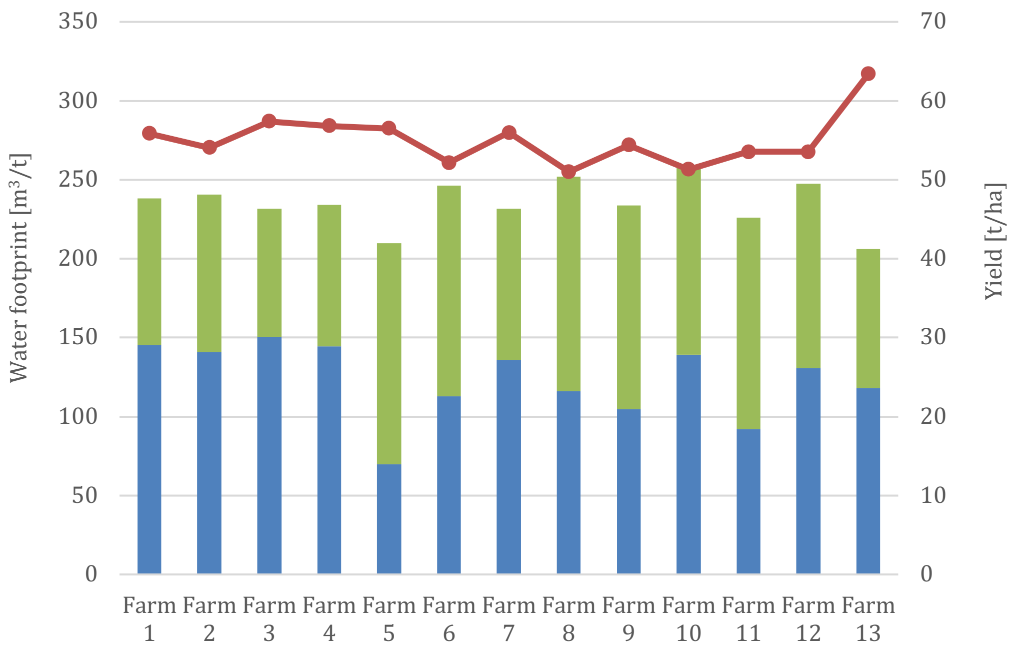


Figure 8. Weighted green and blue water footprint [m^3/t] and yields [t/ha] in 2017 for the 13 farms of the banana supplier.

In the case of Farm 12 (figure 9), with the highest estimated losses (2,972 m^3/ha/year, 29% annual average), losses are around 40% of the irrigation applied in the first 100 days of the year alone. This farm has a higher proportion of soil in class II, which allows a better response to drought conditions. That is, in this farm, it is estimated that a 40% reduction in the irrigation application would be possible without affecting yields for the first 100 days of the year. During the rainy season, irrigation has been unnecessarily applied; see for instance in figure 9 irrigation on day 191 and a significant rain episode the following day (day 192). The generation of rainfall predictions could support watering decisions, in order to increase green water consumption and decrease blue water consumption at the farm level.

The supplying company applies an irrigation module from its own software to its farms. This module does not consider the soil water-holding capacity, so there is no irrigation differentiation in the farms by soil textural class. Furthermore, irrigation operators use the results from the software as guidance, but they also irrigate based on experience or simply by feeling. It seems that they often irrigate more than determined by the software, especially during the dry season. This implies a tangible opportunity for the supplying company in improving irrigation water management, increasing efficiency in green water use and ultimately reducing water withdrawals.

On an annual average, 11.5% irrigation water losses were calculated for all farms, with a maximum of 29% for Farm 12 and a minimum of 1% for Farm 5. During the first three months of the year (100 days), 16% irrigation losses were estimated on average.

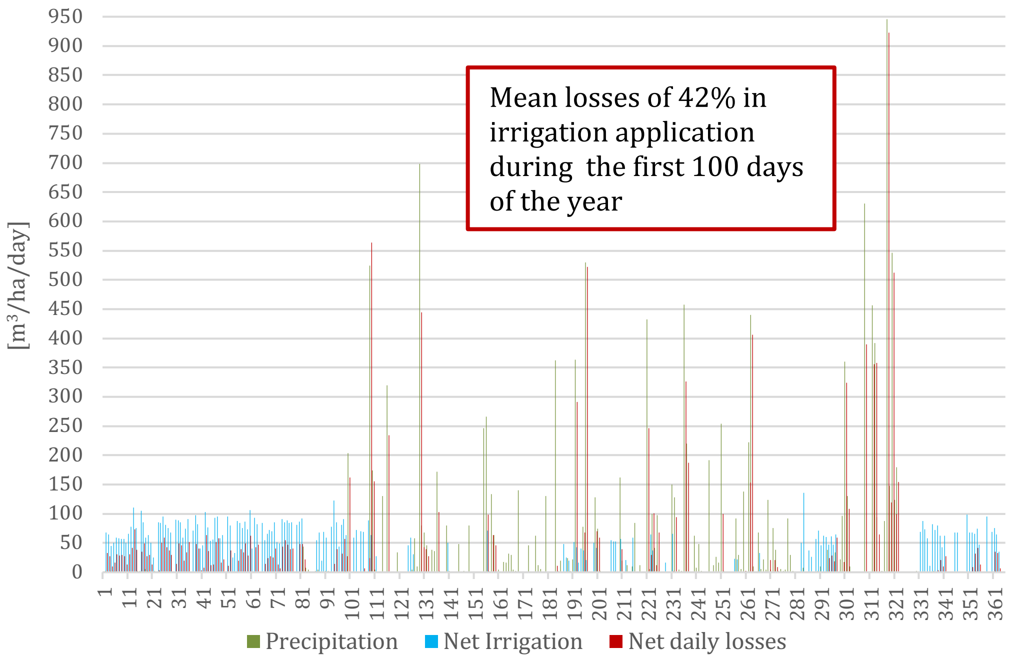


Figure 9. Precipitation, net irrigation and estimated daily losses in the year 2017 for Farm 12.

Setting water targets

The working premise, as agreed and defined by the local banana sector working group, consisted in reducing the water stress in the basin, lowering the monthly Water Use Index (IUA) at least to 1 in the Frio and Sevilla rivers. This was particularly relevant for the first three months of the year, when the actual blue water use was greater than the water flow available for human activities and the environmental flow requirements were non-compliant (IUA>1).

Basin level water targets

Achieving a maximum IUA of 1 would imply reducing the total demand by approximately 42% in the Frio river and by 54% in the Sevilla river, for the first three months of the year (for the base year, 2017).

In this pilot study, the banana working group proposed that the basin-level IUA reductions are to be shared between all the water users in the basin according to their contribution, in this case the banana and palm sector (since basically they are the two predominant water users in the basins). The small banana producers (7.2% of all banana area in the region) and palm producers have the greatest water-use reduction potential since they use more inefficient irrigation systems. The rest, 92.8% of banana production, is marketed through large companies with technified irrigation systems[6].

Additionally, according to the identified irrigation average losses of 16% for the 13 farms in the study during the first three months of the year, and the estimated potential irrigation reductions through the improved irrigation-scheduling and predictions, a reduction potential of 20% was estimated for the rest of the supplying company farms as well as the other large banana producers during the first 3 months of the year. This is an estimation based on results for the 13 farms (16% losses in average) and the fact that, at least for the supplying company, only the 13 farms use the software module to predict crop water needs and actually measure irrigation gifts. It is expected that the remaining farms from the supplying company are less water efficient than the 13 farms of the study, and this is how this 20% was proposed.

To sum up, the following reduction targets were proposed in consultation with the local banana working group for the entire banana and palm sectors operating in Frio and Sevilla rivers:

1. 20% water demand reduction by the large banana sector producers. Applicable to the supplying company, but replicable to other suppliers.

2. 40% water demand reduction by small banana and palm producers. This implies sectoral work with small banana producers and cross-sectoral work with the palm production sector.

Using these percentages, the estimated water demand reductions at the basin level are presented in Table 4.

	Frio basin			Sevilla basin		
	Jan	Feb	Mar	Jan	Feb	Mar
20% reduction applied to 92.8% of the banana producers	1.23	1.32	1.40	1.27	1.36	1.44
40% reduction applied to 7.2% of the banana producers	0.19	0.20	0.22	0.20	0.21	0.22
40% reduction applied to palm producers	1.68	1.64	1.73	2.47	2.40	2.54
Total reduction	**3.11**	**3.16**	**3.35**	**3.93**	**3.97**	**4.21**

Table 4. Proposed water reduction targets for the Frio and Sevilla basins expressed in volume per month, for the first three months of the year *(Mill m^3/month).*

As a first approximation adjusted to the reality of the sector and the basin, this would allow to achieve a total reduction of 28% for the Frio river basin and 30% for the Sevilla river basin (as compared to the estimated required reductions of 42 and 54% in Frio and Sevilla rivers respectively to achieve an IUA = 1 during the first three months of the year). Additional measures would be needed in the future, which would imply greater investment to achieve the IUA reduction goal through demand management.

Supplier water targets and water strategy

The supplier has a cultivated area of 3,790 ha in the Frio and Sevilla basins, with 81.6% of the water supplied from the Frio river and 18.4% from the Sevilla river (Table 5). The 20% water demand reduction target defined in the previous section was allocated accordingly for each basin in the first three months of the year, obtaining reduction volumes of 2.57 and 0.58 Million cubic meters for Frio and Sevilla basins respectively (from the supplier only).

	Jan	**Feb**	**Mar**
Supplier's demand on the Frio river	4.01	4.29	4.55
Supplier's demand on the Sevilla river	0.90	0.97	1.03

[6] Palm and small banana producers use flood irrigation with less than 70% efficiency, compared with large-scale banana farmers, who use precision irrigation systems with an irrigation efficiency of 90%.

Table 5. Supplier's water demand[7] from the Frio y Sevilla rivers [Mill m^3/month].

In the case of the supplier, its water demand reduction contribution would be less in the Sevilla river, and more in the Frio river, where the majority of its acreage is concentrated.

Any additional measure implemented beyond the collaboration with Edeka and WWF for both the 13 farms of the project and the farms outside the project (in the latter case, measuring irrigation or predicting crop water needs, for example), would imply significant investments from the supplier and decisions at its CEO level. For this to become a reality, a clear company water strategy and long-term planning would be required, in order to incorporate this type of water targets into the company's work programme.

As an outcome of the present study, a draft water sustainability strategy for the supplier was developed, aiming at achieving a sustainable blue water balance at the basin level. The strategy was developed in collaboration with its water experts as well as the banana working group, although the company's CEO has not endorsed it yet.

Contributions towards Science-Based Targets for Water thinking

The start of the work outlined within this pilot study pre-dated some of the emerging conversations around the concepts of Context-/Science-Based Targets for water (CBWT/SBWT). However, at the conclusion of this work there are some lessons that can be extracted and that could contribute to the early thinking relating to Context-/Science-Based Targets for Water. Below is a table outlining the current proposed CBWT/SBTW methodological steps and the relevant lessons from this work.

Current proposed SBTW methodological steps	Relevant lessons from this pilot study
Prioritise locations and identification of shared freshwater challenges	• Undertaking a water risk assessment is a useful way to prioritise which locations might benefit from setting targets focused on specific water challenges
Understand the baseline	• Compare recent historical precipitation to ensure that the baseline year for data is representative of a more typical climatic year • The source location of where farm withdrawals its water is a useful starting point to begin to define the appropriate hydrological scale that needs to be quantified
Define "sustainable" boundaries	• Water Use Index (IUA) is ratio between withdrawals and availability (accounting for environmental flows) can be a useful way to define "sustainability" • Defining these boundaries enables the identification of "hot spots" within a year where boundaries may be exceeded • Creating a local water user group to agree what constitutes a "sustainable" boundary can create more local buy-in
Contributions/Allocations	• Completing a site-level water balance is a useful step to be able to understand what "room" there could be for improvement. This can be useful when deciding how much of a contribution the site can have towards what is needed within the basin to meet the defined "sustainable" boundaries. • Scenario analysis on baseline irrigation vs. irrigation scheduling can help to further identify which farms have "room" for reductions based on crop stress, yields and irrigation losses. • Creating a local water user group creates a forum that can agree a socially-negotiated way to distribute how each water user will contribute to meeting the "sustainable" boundaries, and to validate results.
Setting SBWT	• Combining the baseline understanding, site-level water balance analysis and what is "sustainable" in the basin enabled realistic target to be set at each of the sites in the pilot study.

[7] Built from the extrapolation of the irrigation application in the 13 farms analysed to all areas of the supplier in the basins.

	• Realistic water targets can be set for a site, but they need to be developed along a proper business model and aligned with the company's water policy in order to move from paper to reality.

Conclusions

Realistic and meaningful water targets for Edeka's banana supplier in Zona Bananera, Colombia, were developed in consultation with the banana sector working group. The working group was key to validate results, develop down-to-earth water targets and propose measures and activities engaging off-farm basin stakeholders, such as other small banana producers and one palm producer participating passively, and to position the company as a local and sectorial water leader.

The present study showed that it is possible to align the supplier's water targets with the basin environmental water requirements in spite of the existing data gaps and uncertainties.

The water target setting process generated new information that was not previously available in the basin: (1) monthly levels of water stress for the Frio and Sevilla rivers; (2) quantity and origin of the water used by the banana sector in the basins (3) identified key water-using actors; (4) distribution of banana hectares per company; (5) farm level blue water losses and extrapolation to the entire banana sector, (6) links between water losses and reduction volume needed to lower the Water Use Index (IUA) to 1 in the basins, and, (7) roadmap for water demand reductions.

One of the main challenges was to articulate the water targets with the central objective of achieving IUA = 1. The analysis was done at a hydrologically meaningful time scale (month) but for the year 2017 alone (wet year). Short versus long-term scenarios could also be formulated. The water planning and its objectives vary in different types of years –dry, wet and medium. Both the basin and farm level analyses should, ideally, take these variations into account.

This pilot study is clearly a supply-chain driven initiative (part of the larger Edeka – WWF collaboration). For the formulated banana supplying company water targets to move from paper towards an actionable company work programme, a company water strategy able to articulate the water targets needs to be in place. This can only happen in cooperation and constant support from other supply chain partners.

Results from this pilot study will be presented in the context of the Water Stewardship Platform in order to engage the palm sector and other banana companies, as well as Asoriofrio and Asosevilla in the target-setting discussion. Ultimately, we will search to articulate learnings in the Platform's work programme.

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[i] CHIRPS, 2019. Funk, C., Peterson, P., Lansfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., Michaelsen, J. Climate Hayards Group InfraRed Precipitation with Station – a new environmental record for monitoring extremes. Scientific Data 2, 150066. 2015. http://chg.geog.ucsb.edu/data/chirps/.

[ii] Supplier (2017) - Rainfall data from the supplier's weather station in the Frio river, Zona Bananera, year 2017.

[iii] IDEAM (2014) CORINE Land Cover. Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), Colombia. Adapted to the Asoriofrio concessions, which establish a palm area of 974 hectares for 2015. The palm area is greater than the one reported by CORINE, it was adjusted and reduced to the banana.

[iv] CORPAMAG (2015a) Concession - Asoriofrio. Resolution N. 2265, 14/08/2015.

[v] CORPAMAG (2015a) Concession - Santa Ines Canal – Left bank of the Frio river and other direct unidentified concessions.

[vi] CORPAMAG (2015b) Concession - Asosevilla. Resolution N. 3600, 10/12/2015.

[vii] CORPAMAG (2015c) Concession - Asotucurinca. Resolution N. 3717, 21/12/2015.

[viii] The practical steps proposed for the development of water targets for the banana supplying company are based on GSI's WaterData4Action approach.

http://www.goodstuffinternational.com/images/PDF/GSI_Tech_paper_2_Sustainable_water_use_in_agri_supply_chains_WD4A.pdf

[ix] IDEAM Institute of Hydrology, Meteorology and Environmental Studies, Colombia http://www.ideam.gov.co

[x] GSI (2017) Geographic Agricultural Water Footprint Calculator. Available from: http://www.goodstuffinternational.com/index.php/en/component/content/article/67-research-and-education/water-footprint/288-geographic-agricultural-water-footprint-calculator?Itemid=101

[xi] Allen, R. G., Pereira, L. S., Raes, D. and Smith, M. (1998) Crop evapotranspiration: Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper 56, Food and Agriculture Organization, Rome.