E. ASSESSMENT OF ATTRIBUTABLE IMPACTS

1. This section is based on the preliminary findings of the S3P impact assessment (IA) study conducted by the Research and Impact Assessment (RIA) Division of IFAD. S3P is one of the 24 projects selected for IFAD's IA agenda for its 11th replenishment period.[1] The IA study uses rigorous quasi-experimental methodologies to estimate the impacts on beneficiary livelihoods that are *attributable* to S3P interventions.[2] The main outcome indicators of IFAD11 IA agenda are defined in IFAD results management framework as Tier II development impact indicators (Table 1). These are: the Economic Goal (EG) of increasing incomes; the Strategic Objectives (SO) of improving productive capacities (SO1), market access (SO2) and resilience (SO3); as well as mainstreaming themes of nutrition and gender. Table 1 lists the corresponding impact indicators from the IA of S3P, which are summarized below.

Table 1. IFAD11 Tier II development impact indicators

Goal/SO	Definition	I IA Indicators
Goal	Number of people with increased income	Gross total income and asset ownership
SO1	Number of people with improved production	Value of crop production and crop productivity (yields) for relevant main crops, adoption of sustainable agricultural practices and improved planting material.
SO2	Number of people with improved market access	Probability of selling at the market, the share of sale value over the total value, and revenues from sales
SO3	Number of people with greater resilience	Ability to recover from shocks, Gini-Simpson index of crop diversification
Mainstreaming Themes	Number of people with improved nutrition	Food Insecurity Experience Scale (FIES), Household Dietary Diversity Score (HDDS), Months of Adequate Household Food Provision (MAHFP)
	Improved female empowerment	Female participation in income generation, the value of crop production and revenues from crop sales from parcels under female decision making, and female ownership of land, livestock and assets.

2. The IA household survey (IAHS) has been conducted to collect data from 2,000 households (including beneficiaries and non-beneficiaries) including detailed livelihood indicators for the agricultural season 2019/2020. Beneficiary and non-beneficiary households were made comparable using a two stage matching technique (Propensity Score Matching, PSM), first at the ward and then at the household level using a set of observable characteristics[3], which might have affected the selection into the Programme and the outcome indicators. This method ensures that the control group is a good representation of how the treated group would have looked like, had they not received the S3P interventions. Therefore, it allows one to estimate the attributable impact of the Programme isolated from all other factors that affect outcomes. The S3P final evaluation indicates that the focus group respondents assessed that only 62% of the subjective impact reported can be attributable to S3P. This finding underlines the difference between *contribution* and *attribution,* which complement each other, and indicates that in the case of S3P the attributable impact can be expected to be generally lower than the contribution impact highlighted by focus group discussion and stakeholder interviews.

3. A particularly important aspect of IAs conducted in this period relates to the COVID-19 outbreak and the consequent measures to contain its spread, which have affected livelihoods during the agricultural season 2019/2020. The S3P IAHS has included a couple of questions to assess COVID-19 impacts. An anlaysis of these variables indicate that the exposure to COVID-19 was very similar among treated and control households. These variables are also used in the analysis to ensure that the reported findings are not affected by any systematic COVID-19 effect.

4. Table 2 shows selected impact estimates from the S3P IA, suggesting a generally positive impact of the Programme, though impacts on some indicators are not statistically significant. More specifically, significant positive impacts are found on agricultural yields, revenues from crop sales, resilience and the adoption of improved planting materials. Nonetheless, some aspects such as the adoption of agricultural practices such as zero or

[1] IFAD11 IA agenda covers projects that are closing during the three years of 11th replenishment period (2019-2021). Rigorous IAs are conducted for a sample of at least 15% of these projects and then combined in a meta-analysis to report attributable impact of IFAD projects to the board.

[2] The results included in this section are the estimated Average Treatment Effects on Treated (ATET) using the Inverse Probability Weighted Regression Adjustment (IPWRA) method.

[3] See Table 3 for the list of control variables used in the analysis.

minimum tillage remain generally low in the area for both beneficiary and non-beneficiary households. Therefore, further analysis is needed to investigate which factors might constrain or drive the adoption of these practices.

a) Economic goal: household Income and assets

5. Controlling for a large set of variables, the estimated impact of the Programme on the gross total income of beneficiaries is not statistically significant. Total income is composed of multiple income sources, of which cropping income contributes the largest share with 50-60% of the total. Further anlaysis indicates that the cropping income of beneficiary housheolds increased by about 30% compared to that of control housheolds. The estimated attributable impact on asset ownership (measured by ownership of durable goods and quality of housing) is also positive and significant (at 2 percentage points), similar to the contribution impacts based on focus group discussions and stakeholder interviews reported in section D above. However, the ownership of agricultural assets remains notably low. Some goods such as improved cookstoves, water pumps, scotch carts and harrows are almost non-existent in the area (all these tools are owned by less than one percent of the sample). Other goods like trained oxen/cows, ox-drawn ploughs, wheel barrows, hammer mills and knapsack sprayers are instead concentrated in a few households.

b) Strategic objective one (SO1): Agricultural production and productivity

6. The total value of crop production has increased by 12% compared to non-beneficiary households. This impact is mainly driven by higher yields in cassava and maize (by 21 and 10% more than non-beneficiary households, respectively). Even though maize has not been targeted by S3P activities, spillover effects from extension services seem to have positively affected the cultivation of other crops. However, no statistically significant impact is observed on groundnut and mixed bean yields. In addition, rice was cultivated by only eight percent of the sample, thus this low sample size does not allow for a robust analysis.

7. The impacts on the adoption of sustainable agricultural practices such as the compponents of CA (minimum/zero tillage, soil cover, crop rotation), fallowing, agroforestry or erosion control are not statistically significant, except for the impact on crop rotation with legumes, which has increased by 8 percentage points compared to non-beneficiary households. Furthermore, the adoption of agricultural practices as zero or minimum tillage and growing cover crops is very low in the IAHS. For instance, zero tillage has been practised by two percent of the sample, minimum tillage (zero, planting basins and ripping) has been practised by five percent of the sample, while cover crops were cultivated by less than one percent of the sample. On the other hand, other sustainable agricultural practices such as soil cover (through the management of harvest residues), fallowing, agroforestry and erosion control measures, are used much more extensively (64, 48, 26 and 37%, respectively) by the sampled households, however, no statistically significant difference exists between the beneficiary and non-beneficiary households.

8. The estimated Programme impacts on the adoption of improved, hybrid or recycled planting material (across all crops) is signifcant and positive at 18 percentage points. This positive impact has been observed in maize (11 percentage points more than non-beneficiary households) and cassava (9 percentage points more than non-beneficiary households). In the case of cassava, the impact is also observable by focusing only on improved planting material (3 percentage points more than non-beneficiary households) and in some specific varieties like Chila and Mweru (respectively 1 and 5 percentage points more than non-beneficiary households). The adoption of improved seeds in groundnut and mixed beans are lower but still statistically significant (not shown in the table). In particular, the adoption of improved seeds in groundnut has increased by 1 percentage point compared to non-beneficiary households, and adoption of hybrid seeds in mixed beans has increased by 5 percentage points with respect to non-beneficiary households. Nonetheless, the use of improved, hybrid and recycled planting material for cassava, groundnut and mixed beans (11, 12, 16%, respectively) remains low compared to that for maize (82%).

c) Strategic objective two (SO2): Access to markets

9. Market access measured by the probability of selling any crop in the market, increased by 9 percentage points for beneficiaries compared to non-beneficiaries. Increased market access is observed for main crops (i.e. maize, cassava and groundnut, respectively 10, 16 and 7 percentage points more than non-beneficiary households). Looking at the cassava, the increased market access has been driven by the increased sales of processed cassava as chips, which has increased by 14 percentage points compared to non-beneficiary households. As well, beneficiary households have increased the share of crops sold by 5 percentage points with respect to non-beneficiary households. It is interesting to note that the impact of the Programme on crop revenues is higher among farmers who accessed the market. The revenues increased by 38% for beneficiaries compared to non-beneficiaries. As reported, this result could be because beneficiary households have obtained higher selling price as a consequence of the links between organised groups of farmers.

d) Strategic object three (S03): Resilience

10. In terms of indicators of household resilience, the estimated impact is positive and significant on crop diversification, which is expected to increase resilience to various shocks. Looking at the allocation of land across various crops, beneficiary households have increased their diversification by 5 percentage points compared to non-beneficiary households. They cultivated a higher number of crops (on average 3.5 crops for beneficiary households, and 2.9 crops for non-beneficiaries) and had a more equal distribution of land allocated across the cultivated crops.

Furthermore, among the households that experienced a non-climate related shock during the project, beneficiary households were 9 percentage points more likely than non-beneficiary households to recover from the most severe shock. By contrast, no statistically significant impact is found on the self-reported ability to recover from climate related shocks during the project.

e) Nutrition and food security

11. The estimated impacts of the programme on food security and nutrition are positive, similar to the results from focus group discussion and stakeholder interviews. The Months of Adequate Household Food Provisions (MAHFP) has increased by 0.44 months, which means an increase of 5 percentage points with respect to non-beneficiary households. The dietary diversity has also improved. Compared to non-beneficiary households, the Household Dietary Diversity Score of S3P households increased by 0.26, which corresponds to an increase of 3 percentage points. No statistically significant impact is estimated for the Food Insecurity Experience Scale, which is a measure of more severe forms of food insecurity compared to the other indicators.

f) Gender empowerment

12. Although S3P has involved a large number of women in accessing extension services, the estimated impacts on female participation in gross income, agricultural production and crop sale revenues are not statistically significant. At the same time, S3P has increased the female asset ownership in beneficiary households in terms of land (5 percentage points more than in non-beneficiary households) and durable goods (2 percentage points more than in non-beneficiary households). However, these results suggest that targeting women is not sufficient to generate a process of gender empowerment. Other social and cultural factors could constrain women empowerment, which instead would require an integration of gender empowerment approaches in the programme design.

Table 2. Estimate of Average Treatment Effect on Treated (ATET).

Outcome indicator	ATET	Observations
Economic Goal:		
Gross income per capita[a]	0.02 (0.06)	1,948 (T 1,049; C 899)
Durable assets [c]	0.02*** (0.01)	1,948 (T 1,049; C 899)
Productive assets[c]	0.00 (0.00)	1,948 (T 1,049; C 899)
Housing characteristics[c]	0.02* (0.01)	1,948 (T 1,049; C 899)
S01 – Agricultural production and productivity:		
Total value of crop production[a]	0.12* (0.06)	1,927 (T 1,045; C 882)
Yield of cassava[a]	0.21** (0.10)	1,041 (T 593; C 448)
Yield of maize[a]	0.10** (0.05)	1,691 (T 983; C 708)
Zero tillage [b]	0.01 (0.01)	1,948 (T 1,049; C 899)
Minumum tillage [b]	0.00 (0.01)	1,948 (T 1,049; C 899)
Soil cover (growing cover crops or residue management) [b]	0.03 (0.03)	1,948 (T 1,049; C 899)
Rotation with legumes[b]	0.08** (0.03)	1,948 (T 1,049; C 899)
Fallow land[b]	-0.01 (0.03)	1,948 (T 1,049; C 899)
Agroforestry [b]	0.01 (0.03)	1,948 (T 1,049; C 899)
Erosion control measures [b]	0.01 (0.03)	1,948 (T 1,049; C 899)
Seed adoption (Improved/Hybrid/Recycled) [b]	0.18*** (0.04)	1,937 (T 1,047; C 890)
Seed adoption for cassava (Improved/Hybrid/Recycled) [b]	0.09*** (0.03)	1,167 (T 666; C 501)
Seed adoption for maize (Improved/Hybrid/Recycled) [b]	0.11*** (0.03)	1,701 (T 985; C 716)
S02 – Market access:		
Crop market access[b]	0.09***	1,932

	(0.03)	(T 1,047; C 885)
Share of sales value in total value of production [(c)]	0.05*** (0.02)	1,632 (T 948; C 684)
Revenues from crop sales[(a)]	0.38*** (0.08)	1,630 (T 946; C 684)
S03 – Resilience:		
Crop diversification (Gini-Simpson index 0-1) [(c)]	0.05*** (0.01)	1,948 (T 1,049; C 899)
Ability to recover from the most severe non-climate shock during the project [(b)]	0.09*** (0.03)	1,712 (T 949; C 763)
Ability to recover from the most severe climate shock during the project [(b)]	0.01 (0.04)	1,267 (T 711; C 556)
CT – Nutrition:		
MAHFP (0-12) [(c)]	0.44*** (0.15)	1,948 (T 1,049; C 899)
HDDS (0-12) [(c)]	0.26** (0.10)	1,948 (T 1,049; C 899)
FIES[(c)]	-0.14 (0.18)	1,948 (T 1,049; C 899)
CT - Gender empowerment:		
Female participation in gross income [(b, e)]	-0.04 (0.03)	1,948 (T 1,049; C 899)
Female participation in total value of crop production [(b,e)]	0.00 (0.02)	1,927 (T 1,045; C 882)
Female participation in revenues from crop sales [(b,e)]	0.01 (0.02)	1,632 (T 948; C 684)
Female ownership of land [(b)]	0.05*** (0.01)	1,948 (T 1,049; C 899)
Female ownership of livestock [(b)]	0.02 (0.02)	1,948 (T 1,049; C 899)
Female ownership of durable goods [(b)]	0.02* (0.01)	1,840 (T 1,011; C 829)

Note. ATET is estimated using Inverse Probability Weighted Regression Adjustment after two-stage of Propensity Score Matching at ward level (treated and control wards) and household level (treated and control households). (a) the variable is the arcsinh transformation from; (b) the variable assumes the value of 1 if yes and 0 otherwise; (c) the variable is expressed as constructed. Standard errors are in parentheses; (e) female participation in income/revenue sources is measured by using the answers to the question of "who makes the decisions on…" for each parcel/income generating activity. Statistical significance: *<0.10; **<0.05; ***<0.01.

Appendix

Table 3. Variables used in the estimation of IPWRA.

	Gross income per capita	Assets (durable; productive; housing)	Agricultural production and yields	Sustainable agricultural practices	Seed adoption	Market access for crop	Crop diversification	Ability to recover from shock	Food security	Gender empowerment
Control variables in the outcome equation										
No. of children (<=5)	x	x	x	x	x	x	x	x	x	x
No. of young people (6-14)	x	x	x	x	x	x	x	x	x	x
No. of adults (15-64)	x	x	x	x	x	x	x	x	x	x
No. of women (>=15)	x	x	x	x	x	x	x	x	x	x
Dependents over productive (15-64)	x	x	x	x	x	x	x	x	x	x
If any household member has a disability (1=yes)	x	x	x	x	x	x	x	x	x	x
Average years of education of household members>=15	x	x	x	x	x	x	x	x	x	x
Female household head (1=yes)	x	x	x	x	x	x	x	x	x	x
Age of household head in years	x	x	x	x	x	x	x	x	x	x
Age of household head in years (squared)	x	x	x	x	x	x	x	x	x	x
Household head is married (1=yes)	x	x	x	x	x	x	x	x	x	x
Tropical Livestock Unit at baseline	x	x	x	x	x	x	x	x	x	x
MCA index of housing assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
PCA index of durable assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
PCA index of productive assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
Land owned (Ha.)	x	x	x	x	x	x	x	x	x	x
No. of dry dekads within the season 2019/20	x	x	x	x	x	x	x	x	x	x
Tot seasonal rain 2019/20	x	x	x	x	x	x	x	x	x	x
CoV dek rain within season 2019/20	x	x	x	x	x	x	x	x	x	x
Avg seasonal mean temp 2019/20	x	x	x	x	x	x	x	x	x	x
No. of dek with a max temp >= 28 within season 2019/20	x	x	x	x	x	x	x	x	x	x
Population density in 2019 (100m grid cells from WorlPop data)	x	x	x	x	x	x	x	x	x	x
Density of roads in the 20 Km neighborhood	x	x	x	x	x	x	x	x	x	x

Travel time to the next 5-10k city in minutes	x	x	x	x	x	x	x	x	x	x
If household experienced any non-climate shock in the last 12 months (1=yes)	x	x	x	x	x	x	x	x	x	x
If household received any transfer as COVID response (1=yes)=1	x	x	x	x	x	x	x	x	x	x
Covid intensity (Pca index normalized 0-1)	x	x	x	x	x	x	x	x	x	x
If household received any transfer as COVID response (1=yes)=1#Covid intensity pca index (0-1)	x	x	x	x	x	x	x	x	x	x
Province (Luapula; Muchinga; Northern)	x	x	x	x	x	x	x	x	x	x
If the ward benefited from SAPP project (1=yes)	x	x	x	x	x	x	x	x	x	x
If the ward benefited from CASU project (1=yes)	x	x	x	x	x	x	x	x	x	x
If the ward benefited from other projects for sustainable agriculture (1=yes)	x	x	x	x	x	x	x	x	x	x
Farm size (small; medium; large)	x		x	x	x	x	x			
If in the community FISP distribution depot is available (1=yes)	x		x	x	x					
If in the community Private fertiliser retailer is available (1=yes)	x		x	x	x					
If in the community FRA depot is available (1=yes)	x					x				
If in the community Market place for agricultural products is available (1=yes)	x					x				
If some portion of land is very/moderately fertile (1=yes)			x							
If some portion of land is irrigated (1=yes)			x							
If any organic or chemical fertilizer is applied (1=yes)			x							
If any phytosanitary product is applied (1=yes)			x							
If any paid labor is used (1=yes)			x							
Matching variables in the selection equation										
No. of children (<=5) at baseline	x	x	x	x	x	x	x	x	x	x
No. of young people (6-14) at baseline	x	x	x	x	x	x	x	x	x	x
No. of adults (15-64) at baseline	x	x	x	x	x	x	x	x	x	x
No. of women (>=15) at baseline	x	x	x	x	x	x	x	x	x	x
Dependents over productive (15-64)	x	x	x	x	x	x	x	x	x	x
If any household member has a disability (1=yes)	x	x	x	x	x	x	x	x	x	x
Average years of education of household members>=15 at baseline	x	x	x	x	x	x	x	x	x	x
Female household head (1=yes)	x	x	x	x	x	x	x	x	x	x
Age of household head in years at baseline	x	x	x	x	x	x	x	x	x	x

Age of household head in years at baseline (squared)	x	x	x	x	x	x	x	x	x	x
Household head is married (1=yes)	x	x	x	x	x	x	x	x	x	x
Tropical Livestock Unit at baseline	x	x	x	x	x	x	x	x	x	x
MCA index of housing assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
PCA index of durable assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
PCA index of productive assets at baseline (normalized 0 to 1)	x	x	x	x	x	x	x	x	x	x
Titled state land owned (Ha.)	x	x	x	x	x	x	x	x	x	x
Untitled state land owned (Ha.)	x	x	x	x	x	x	x	x	x	x
Titled customary land owned (Ha.)	x	x	x	x	x	x	x	x	x	x
Untitled customary land owned (Ha.)	x	x	x	x	x	x	x	x	x	x
Community land owned with chief certificate (Ha.)	x	x	x	x	x	x	x	x	x	x
Percentage of households engaged in agriculture within the ward (%) (CSO 2010)	x	x	x	x	x	x	x	x	x	x
Percentage of households growing maize within the ward (%) (CSO 2010)	x	x	x	x	x	x	x	x	x	x
Percentage of households growing cassava within the ward (%) (CSO 2010)	x	x	x	x	x	x	x	x	x	x
Percentage of households growing mixed beans within the ward (%) (CSO 2010)	x	x	x	x	x	x	x	x	x	x
Percentage of households growing groundnuts within the ward (%) (CSO 2010)	x	x	x	x	x	x	x	x	x	x
Ratio of CoV of tot seasonal rain before the project (2011/13 over 2001/10)	x	x	x	x	x	x	x	x	x	x
Ratio of CoV of avg seasonal mean temp before the project (2011/13 over 2001/10)	x	x	x	x	x	x	x	x	x	x
Ratio of CoV of avg seasonal max temp before the project (2011/13 over 2001/10)	x	x	x	x	x	x	x	x	x	x
Ratio of CoV of avg seasonal EVI before the project (2011/13 over 2001/10)	x	x	x	x	x	x	x	x	x	x
Population density in 2013 (100m grid cells from WorlPop data)	x	x	x	x	x	x	x	x	x	x
Growth rate of population density 10 years before project (2003-2013)	x	x	x	x	x	x	x	x	x	x
Avg. total seasonal rain 1981/2019	x	x	x	x	x	x	x	x	x	x
CoV of tot seasonal rain 1981/2019	x	x	x	x	x	x	x	x	x	x
Avg of avg seasonal mean temp 1981/2019	x	x	x	x	x	x	x	x	x	x