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Agribusiness Firms and Rural Dairy Development. A Case of FrieslandCampina Dairy Development Programme in Nigeria

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Abstract

Rural development interventions funded by private agribusiness firms may positively or negatively affect rural farmers' welfare. A positive effect is that such interventions may provide farmers with market access. The negative effect could be that such firms may be solely motivated by profit and may exploit the farmers. In this paper, we explore the role of FrieslandCampina Dairy Development Programme, a multinational firm with headquarters in Europe, in improving the welfare of rural dairy farmers in Nigeria. We use a two-wave panel survey of 122 programme participants and 95 non-participants. We focus on two outcome measures – annual dairy income and daily milk yield - and use a pooled ordinary least squares method to understand the programme effect. We also explore the mechanism of effect by assessing the programme effects on farmers' sustainable dairy management practices using a negative binomial regression method. Our results suggest that the programme has positive welfare effects on farmers. We attribute these effects to farmers' access to reliable markets offered by the programme and the informal business arrangement between the farmers and the agribusiness firm. Potential policy implications include that governments should encourage other private agribusiness firms to set up similar development programmes.

Keywords

Dairy, Nigeria, agribusiness firms, FrieslandCampina, rural farmers.

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Introduction

In the last two decades, the roles large agribusiness firms, mostly with headquarters in Europe, play in strengthening the agricultural and rural sectors in developing countries have been of interest to researchers and policymakers. Agribusiness (agro-processing) firms have been broadly involved in supplying rural farmers with inputs and new technology (Arouna et al., 2019), providing rural households with social amenities (Michelson et al., 2017), and serving as reliable markets for products of rural households (Meemken and Bellemare, 2020). However, evidence on the impacts of the firms' activities on rural farmers' welfare varies greatly in literature. Singh (2002) believes that large firms often camouflage as having good intentions towards developing the rural economy, but many agro-processing firms' harbour exploitative motives towards rural farmers. Firms are motivated by profit, and in a bid to smaximise profit, firms involved in contract arrangements with rural farmers may, for example, offer farmers uncompetitive prices thereby short-changing the farmers (Ngeleza and Robinson, 2013). Moreover, firms' activities in rural areas are often not voluntary, and many firms would rather not participate in the sector. But because of specified corporate social responsibility - CSR (Setboonsarng, 2008) or government policies (Glover, 1984, Bonilla et al., 2018), firms are forced to engage in rural sector development. Hence, using the FrieslandCampina Dairy Development Programme (DDP) as a case study, we explore the role of agro-processing firms in improving rural farmers' market access and welfare.

FrieslandCampina West Africa Milk Company (WAMCO) Nigeria Limited is a private multinational firm with headquarters in the Netherlands, and it is the largest importer and processor of milk products in Nigeria (Köster and de Wolff, 2012). The company, like many other major milk processors in the country, mainly repackages and reconstitutes imported powdered and evaporated milk products. However, in line

with the Nigerian government's Local Content Act (LCA) of 2010 and the government's objective of growing the agricultural sector, the company decided to increase its local content to 10% by locally sourcing fresh milk from local farmers. Hence the company launched the DDP in 2011, setting up four milk collection centres (MCCs) and targeting local dairy farmers, mostly Fulani cattle herders, located within 30kms to any MCCs. The programme also provides participating farmers with training on efficient farming techniques and link the farmers with input suppliers, to improve the quality of milk farmers supply to the MCCs.

Generally, abundant literature exists linking dairy development interventions in developing countries to rural farmers welfare improvement (Holloway et al., 2000; Yahuza, 2001; Bonilla et al., 2018). In Nigeria, for example, Yahuza (2001) explores various milk development schemes in the country targeted at improving the production and marketing of dairy products. He notes that despite government investment in dairy development, the gap between supply and demand for dairy products continues to widen, thus recommends the need to involve other actors (like the private sector) in rural dairy development. However, there is no known empirical evidence on the importance of private sector involvement in rural dairy development in Nigeria. However, in Kenya, which has a more developed dairy sector than Nigeria, Bonilla et al. (2018) find that the Smallholder Dairy Commercialisation Programme (SDCP) was successful in increasing market access and rural welfare.

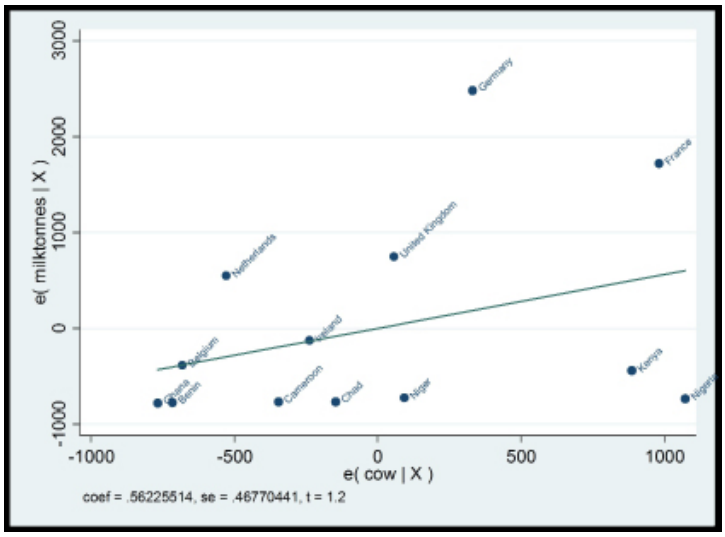
Development interventions, generally, can affect rural farmers' welfare through many channels. Bayer and Kapunda (2006) note that development programmes targeted at increasing farmers' market access often increase productive asset investment, like herd size. The authors attribute this increase to access to a guaranteed market outlet which may, in turn, lead to an increase in farmers welfare. Gelan and Muriithi (2015) and Bonilla et al. (2018) note that farmers welfare is improved by adopting sustainable dairy management practices such as improved feeding practices and hygiene techniques, and such practices may lead to increased milk production efficiency and earnings. Holloway et al. (2008), Barrett et al. (2012), Burke et al. (2015), and Edirisinghe and Holloway (2015), however, note that the proximity of farmers to infrastructural facilities and processing sites may also be associated with the farmers' welfare. Though, Stiglitz (1989) argues that, although development interventions may ameliorate the adverse effect of market imperfection and provide positive welfare effects, the effect large firms in ameliorating such market failures and imperfection, may be insignificant especially in developing countries. We, therefore, answer the following questions:

- Does the FrieslandCampina Dairy Development Programme improve the welfare of rural dairy farmers?
- Is the use of sustainable dairy management practices linked to dairy farmers' welfare? That is, is the pathway of programme effect through farmers' use of sustainable dairy management practices?
- Are there differences in programme participation effects across various socio-economic groups?

The FrieslandCampina DDP is a relevant case study within rural studies and development economics literature due to the objective of the programme to increase farmers' access to market and develop rural farmers welfare. Our study will add to the literature addressing the relevance of agribusiness firms in rural welfare development. The programme is also relevant to a broader audience because, unlike many other development programmes, it is mainly funded by a private (multinational) agribusiness firm whose main aim is profit-making and whose products are sold in many West African countries. FrieslandCampina also has the largest market share of about 75% in the Nigeria diary industry.

Understanding the effects of FrieslandCampina Dairy Development is also particularly valuable considering the trade relationship between Europe and Nigeria (and SSA as a whole) with regards to the dairy sector.

Figure 1 shows that although sub-Saharan Africa has a large cattle population, there is low total milk production which makes the countries major importers of milk dairy products. While having roughly the same number of cattle, SSA countries (below the curve) import milk from European countries (above the curve). However, with the steep increase in the prices of dairy commodities on the international market due to growing global demand for milk (mainly from China), droughts, fluctuation of the exchange rate in SSA, and the weakening of the Euro, other multinationals in Europe may seek to source milk from the untapped local dairy sector in developing countries (Leister et al., 2013, Knips, 2005).



Source: authors

Figure 1: Relationship between cattle population and milk production by countries.

The remaining section of this paper is as follows: section 1 further describes the FrieslandCampina DDP. Section 2 describes the data employed for this study and gives the empirical strategy employed to answer the research hypotheses. Section 3 provides the descriptive results and gives the results and discussion from our empirical analyses, and section 4 shows the conclusion and policy implication of this research.

Nigeria dairy sector and FrieslandCampina Dairy Development Programme

In this section, we give a brief description of the Nigeria dairy sector compared to the dairy sector of the developed world. We also give a brief history and explain the governance restructure of the FrieslandCampina DDP, and we explain the nature of the business arrangement between the agribusiness firm (FrieslandCampina) and the farmers.

Nigeria and the global dairy sector

The structure of the dairy sector in Nigeria is characterised by fragmented smallholder dairy farmers, mostly Fulanis, and unorganised farms operating on a non-commercial basis with farmers operating without government support and subsidies. Although the country has one of the largest cattle population in the world, the farmers are subsistence, have no access to storage facilities and use crude techniques for production, thereby resulting in low production. The local breeds of cattle reared by farmers are also low yielding, mainly meat producers and not high milk producers as compared to other exotic breeds. For example, the white Fulani breed yields only about an average of 0.7 – 1.5 litres of milk per day (Michael et al., 1991) while the pure exotic breeds such as Fresian can give about 8 to 18 litres of raw fluid milk per day (Ilu et al., 2016). On the other hand, the dairy sector in developed counties is well organised. Farmers in developed countries like the Netherlands operate in cooperatives and have access to producer subsidies from governments to encourage surplus production which is exported to the global markets. Knips (2005) note that the EU spends about Euro 16 billion a year in support of its dairy industry, and the farmers use sustainable dairy management practices and have access to improved technology and facilities to help increase production.

Dairy is one of the most important products consumed by Nigerians with an estimated annual milk consumption of 1.7 million tonnes, and the local production is only 0.6 million tonnes per annum. The demand for dairy products continues to increase with increasing population and urbanisation, and the importation is used to bridge the demand gap despite the high cattle population. However, dairy importation comes at a cost as Nigeria expends about $480.3 million per annum on dairy importation from countries such as Australia, New Zealand, the European Union, India and the United States of America (Ekumankama et al., 2020). Policymakers seek ways to reduce the foreign exchange expense on milk importation, increase global milk output, and reduce global poverty and inequality through public-private partnerships with SSA governments

and private firms in developed countries. An example of such an intervention is the Diary Development Programme.

Dairy Development Programme: governance structure and responsibilities

In line with the Nigerian government's Local Content Act of 2010, FrieslandCampina signed a Memorandum of Understanding(MoU) with the Federal Ministry of Agriculture and Rural Development in 2011 and went on to set up four MCCs in Fulani settlements in Oyo State, Nigeria. The programme was placed in Oyo state because of the proximity to Lagos state, where the processing factory is located, and the cattle population in the state. Figure 2 depicts the map of Nigeria, showing cattle population and distance to the agro-processing firm in Lagos, Nigeria.

Fulani cattle herders are the major milk producers in Nigeria, and cattle rearing is regarded as part of the Fulani culture. However, only the settled and semi-nomadic Fulani farmers in Oyo state are targeted under the DDP. According to the company, the programme was set up to build institutional capacity and self-organisation to enable the farmers to become partners in a coordinated Dairy Value Chain (DVC), thereby advancing rural dairy development in Nigeria.

DDP is being governed by core partners, namely FrieslandCampina West Africa Milk Company (WAMCO), hereafter referred to as FrieslandCampina, 2SCALE/International Fertilizer Development Center (IFDC) and the Federal Ministry of Agriculture and Rural Development (FMARD), with contributions from Fulani Milk Producers (FMPs) and inputs suppliers (Köster and de Wolff, 2012). Under this programme, the Fulani herdsmen are supported through consistent training and demonstrations to upgrade their milk supply regarding quantity and quality. They are also trained on other improved and sustainable farming techniques such as the use of crop residues and fortification as sources of good feed to cattle, feed preservation through silage and haymaking and crossbreeding through artificial insemination.

These extension services are carried out in partnership with the IFDC/2SCALE project, whose main activities have been geared towards poverty alleviation and income security and building institutional capacity and self-organisation in Nigeria (Köster and de Wolff, 2012). FrieslandCampina has the responsibility of intermediation in the sale of veterinary drugs at the MCCs and offering basic extension assistance to the farmers on an effective herd health programme, milking hygiene and quality. The FMARD has the responsibility to finance and construct grazing reserves, feeder roads, water dams, boreholes and other structures. It also delivers efficient communal veterinary services in the MCC clusters like various vaccination campaigns, eradicating tsetse flies (Köster and de Wolff, 2012).

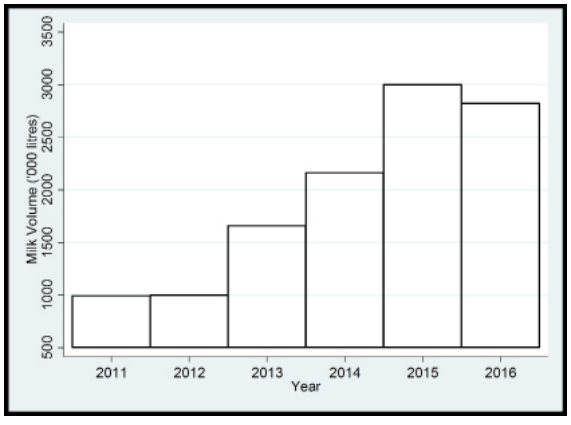
Source: authors

Figure 2: Map of Nigeria showing the Cattle Distribution and Estimated Distance of Cattle Dense States to Lagos.

Purchasing arrangements and price determination

The relationship (arrangement) between the farmers and the agro-processing firm is informal, with no rigid duration. However, programme eligibility is based on the distance to any of the MCCs. Farmers should be located within a 30 km radius and are expected to supply good quality milk daily (every morning), usually before 9.00 am. After that, the milk goes through different quality checks and control at the MCCs and can either be rejected or accepted. FrieslandCampina has the responsibility of daily receiving and controlling milk at the MCCs. Milk may either be brought by the transportation agent or by the farmer. The milk is usually stored and transported using specially fabricated cylinders (10, 20 and 40 litres capacity) given to farmers for free (Köster and de Wolff, 2012).

Milk collected at all MCCs is sent to the milk bulking centre for bulking further quality check before transporting to the processing factory in Lagos (about 220 km to these MCCs and milk bulking centres), where an additional quality check is done. Milk collection, bulking, and transportation to the agro-processing firm is done daily. From the inception of the programme in 2011 to October 2017, about 13,068,319 litres of milk has been collected from the farmers (Figure 3).



Source: authors

Figure 3: Milk Supply Trend (2011 -2016).

The quantity supplied increased with the opening up of additional milking clusters and MCCs. However, the amount supplied dropped by 6% between 2015 and 2016. As of 2016, there were four MCCs and one milk bulking centre (MBC). The MBC is in Iseyin, and the four functional MCCs are in Fashola, Alaga, Maya and Iseyin towns in Oyo State (Ekumankama et al., 2020).

Fixed and uniform prices are paid per litre of milk supplied by the farmers to the MCCs all year-round; prices are not seasonal. Prices were determined through collective bargaining between the collaborating parties. However, prices paid are often lower (on average) than the prevailing price in the informal (public/open-air) market. Fees are paid in cash or through banks. Fees include the cost of transportation ($0.096/litre of milk) and milk value ($0.576/litre of milk) (Köster and de Wolff, 2012).

Materials and methods

Our study area is Oyo state, Southwest Nigeria, and the target population are Fulani dairy farmers located within a 30 kms radius to any of the MCCs, that is, falling within the region of the DDP. Figure 4 shows the map of Oyo state showing the vegetation belts and the location of the MCCs. Oyo state is located within latitudes 70 and 9010'N, and longitudes 2040' and 4035'E and covers 28,454 square kilometres. The state has an estimated population of 5,580,894 people and 33 Local Government Areas (LGAs) (National Population Commission, 2006). The state has a West African monsoon climate, marked by distinct seasonal shifts in the wind pattern. The average daily temperature ranges from 25°C to 35°C. The vegetation of the state is mainly swamp forests with small areas of rainforests and deciduous forest/savannah mosaic scattered in between, making it suitable for cattle rearing.

Source: authors

Figure 4: Oyo state map showing the vegetation belts and the location of the MCCs.

We carry out two surveys with the help of independent extension agents familiar with the area covered by the DDP. Our idea is that since we do not have baseline statistics of farmers, a panel survey of farmers will help increase the precision of the programme effect estimates. We do not, however, expect much variation in farmers characteristics between these periods. The initial survey was in July/August 2016 and a follow-up survey in June/July 2017, and hereafter, we refer to the initial survey as wave 1 and the follow-up survey as wave 2. It is important to note that, although we expect seasonal variations in dairy income and yield, we do not account for seasonal variations as both surveys fall during the rainy season.

We randomly sample farmers located within 30kms to any of the four MCCs, and the sample includes 217 farmers, including both participants (122) and non-participants (95). We select participating farmers using a list of all programme participants (1720) provided by FrieslandCampina field officers and the non-participating farmers from a list provided by the local heads around each of the MCCs. We recognise that a household may consist of more than one dairy farmer; hence we survey one farmer per household, and our study sample is made up of farmers from separate households. Although the intrahousehold dynamics may be of interest for other studies, for simplicity, our unit of analysis is at the individual, not household, level.

Using interview schedules and questionnaires, we collect data on the farmers' characteristics: sex, education level, programme participation status, distance to MCCs, distance to the local market, herd size annual income and output and sustainable management practices farmers use. Our measures of welfare are farmers' annual dairy income and average daily yield per cow. We do not use total income or consumption to measure welfare because farmers often find it hard to recall such information and using such for our analysis may bias our estimates. Data on average yield per cow is for yield per cow on the day of the survey interview. It is important also to note that, although the difference in yield may be attributed to the breed of the cow, the respondents in this sample and dairy farmers in the south-western part of Nigeria rear mostly the White Fulani breed of cattle due to its resistance to trypanosomiasis (RIM, 1992). Hence, we do not expect a difference in yield to be linked to the breed of cow. Exploring two outcome measures is important for comparison and robustness since both measures are only approximations of the real values and based on recall for many of the farmers.

We use the (FAO, 2011) list of sustainable dairy management practices to identify the sustainable practices required by the farmer. The use of these practices by farmers ensures that the milk produced is safe and suitable for their intended use. The practices focus on six main dimensions, and each area has different indicators. These dimensions include animal health (21), milking hygiene (15), nutrition (14), animal welfare (22), environment (10), and socio-economic management (13). Note that the values in round brackets are numbers of indicators for each of the dimensions. For each of the indicators (and for each dimension), farmers are asked closed-ended questions, like if they use a particular dairy management practice. Farmers are expected to give either a yes or a no answer. A farmer that answers yes is regarded as using that management practice. For instance, using one of the 13 indicators of sustainable socio-economic management practices as an example, we ask if the farmer complies with relevant occupational health and safety requirements. A yes = 1 and no = 0. A farmer who answers yes to all 13 indicators of sustainable socio-economic management is considered as employing all the sustainable socio-economic management practices, while a farmer who uses none employs no sustainable socio-economic management practice. The same interpretation applies to each of the six dimensions. A sum of all the indicators of the dimensions gives the total number of sustainable dairy management practices (95) we consider for this study. However, it is important to note that this sustainability is limiting as we do not account for the duration, degree or extent of use.

We also use administrative data such as daily milk output, farmer list, details on MCCs. The data were collected from FrieslandCampina and 2SCALE/ International Fertilizer Development Center (IFDC).

Empirical strategy

In this section, we describe how we analyse the effect of FrieslandCampina DDP on farmers' welfare by testing the following hypotheses:

- The FrieslandCampina Dairy Development Programme has positive welfare effects on rural dairy farmers.

- Farmers' use of sustainable dairy management practices has a positive effect on farmer's dairy yield, and the effect is larger for the programme participants than the non-participants.
- Heterogenous differences in programme participation exist across various socio-economic groups. The effect of the programme is larger among farmers' residing close to any of the MCCs compared to those living far ways.

It is important to note here that making causal claims about the programme effect is difficult as unobserved variables may be correlated with farmers participation status and the farmers' welfare. A group of farmers may self-select into the programme, or the agribusiness firm may have placed the programme close to a targeted group of farmers. These situations (self-selection bias and programme placement bias) may lead to endogeneity which may confound our estimation. Hence, we employ a pooled OLS model which accounts for omitted variables to the extent that these unobserved factors are time-invariant farmers' characteristics, and the model for testing the effects of the programme on farmers is given as:

$$Y_{it} = \beta_0 + \beta_1 P_i + \beta_2 D_i + \beta_3 P_i D_i + \\ + \sum_{x=1}^{6} (\beta_4 S_i^x + \beta_5 S_i^x \times P_i) + \\ + \beta_6 I_{it} + \beta_7 T_i + \varepsilon_{it} \quad (1)$$

Y_{it} is the outcome measure of interest - logarithm of the annual dairy income or yield - of farmer i in period t. P_i is the farmers' participation status, where 1 represents programme participants and 0, non-participants. We do not expect the farmers' participation status to change over time. β_1 shows the effect of programme participation on farmers' welfare. This estimate is expected to be positive. Our identifying variable is farmers' distance to MCC in kilometres (D_i) as this is an important criterion for participating in the programme, and it is, therefore, a good predictor of participation. β_2 is the parameter estimate showing the effect of distance to MCC on farmers' welfare. This relationship is expected to be negative. We also include the interaction of farmers' participation status and distance ($P_i D_i$).

$\sum_{x=1}^{6} S_i$ is the vector of sustainable dairy management practice, x, that farmer i use and the interaction term with farmers participation status P_i. We have six dimensions of sustainable dairy management practices, indexed by x: animal health, milking hygiene, nutrition, animal welfare, environment, and socio-economic management. I_{it} represents a vector of farmers' characteristics such as distance to market (in kilometres), age (in years), square of age, sex (male = 1, female = 0), education level (no formal education = 0, primary education = 1, lower secondary = 2, higher secondary = 3 and tertiary = 4), household size, number of lactating cows, and size of land owned (in hectares). The farmers characteristics also include a control for MCC (0 = Maya, 1 = Alaya, 2 = Fashola, and 3 = Iseyin). All farmers (including non-participants) are attributed to the MCC closest to them. T includes a control for survey wave (wave 1 = 1 and wave 2 = 0) and the interaction between the survey wave and the farmers' participation status. We, however, note that the pooled OLS model does not consider possible selection bias in programme participation which could confound programme effect estimation. For example, participants may be more productive than non-participants and have higher dairy income regardless of whether they participate in the programme.

To test the second hypothesis, the mechanism of programme effect on farmers welfare is through farmers use of sustainable dairy management practices. We employ a negative binomial regression model and express the model as follows:

$$S_i^x = \delta_0 + \delta_1 P_i + \delta_2 D_i + \delta_3 P_i D_i + \delta_4 I_{it} + \epsilon_i \quad (2)$$

S_i^x is the number of sustainable dairy management practices, x, that farmer i use. We run separate regressions for the total sum of the sustainable dairy management practices farmers use and for each of the six dimensions mentioned earlier. All other variables are as earlier explained. We also test for overdispersion to check if the negative binomial model is a better choice compared to the Poisson model, but we do not discuss the results.

We also test for the third hypothesis, which states that differences exist in programme effects across various socio-economic groups. We group farmers into the following categories: sex (male versus female), age (old versus young), distance to MCC (close versus far), education (educated versus not educated), and MCC location (Alaya, Fashola, Maya, Iseyin). And we restrict our analysis (using equation 1) to each of these subgroups. We consider farmers to be old if they are above 35 years of age and young if 35 years or below. Farmers close to the MCC are within a 20km radius to any of the MCC, while those far away are above 20 km but still within a 30 km radius to any of the MCCs.

Educated farmers are at any level of education (primary, secondary or tertiary), while uneducated farmers have no formal education. We also compare farmers within the same MCC location. All farmers (including non-participants) are attributed to the MCC closest to them.

Results and discussion

Exploring the link between FrieslandCampina DDP and rural dairy farmers' welfare requires an understanding of farmers' characteristics and farm statistics. In this section, we first present and discuss the results from the descriptive statistics. We explain the results from the empirical analyses, testing each of the three hypotheses we stated earlier.

Farmer characteristics

Table 1 shows the summary of basic characteristics at wave 1 of farmers in our survey. Columns 1 and 2 show the average and standard deviation values of all the farmers in the sample, columns 3 and 4 show the values for participants, and columns 5 and 6 for the non-participants. The last column shows the differences in the mean values of the characteristics of programme participants and non-participants.

Participants live closer, on average, to any of the four MCCs than non-participants. The participants also tend to be more highly educated, and female farmers form a larger share of the participants compared to the non-participants. We take caution in explaining the results because we do not have baseline statistics of the farmers. Hence, we cannot say if these farmers (educated farmers, female farmers and farmers living close to the MCCs) self-selected into the programme. However, we note that the programme may have been specifically targeted at female farmers, mostly in charge of household milk production and marketing (Bonilla et al., 2018). We explain the problem of self-selection (and then endogeneity) in the empirical strategy section of this paper.

Nevertheless, we find no statistically significant difference between the averages of the two groups concerning their age, household size, herd size (number of lactating cows), and size of land owned, and distance to the commercial market.

Farmers' welfare

We use two measures of welfare for our study. These are annual dairy income and average daily milk output per cow (yield). Table 2 shows the summary statistics of farmers' dairy income and yield at waves 1 and 2. Columns 1 and 2 show the average values for the participants and non-participants, respectively, and column 3 shows the t-test difference (diff) in the mean between the two groups of farmers for each of the waves. The table also shows the t-test difference (Diff) in mean across time for each of the groups of farmers.

	Total		Participants		Non-participants		diff
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev	
Distance to MCC (km)	21.05	5.47	19.44	5.58	23.11	4.59	3.663***
Distance to market (km)	32.71	9.71	32.35	8.49	33.18	11.11	0.826
Age	37.19	10.52	36.86	11.52	37.62	9.11	0.76
Female (%)	46.08	49.96	54.1	50.04	35.79	48.19	-0.183**
Male (%)	53.92	49.96	45.9	50.04	64.21	48.19	0.183**
Household size	8.04	3.74	8.08	3.78	7.98	3.71	-0.103
No formal education (%)	24.88	43.33	4.1	19.91	51.58	50.24	0.475***
Primary (%)	64.98	47.81	80.33	39.92	45.26	50.04	-0.351***
Lower secondary (%)	3.69	18.89	5.74	23.35	1.05	10.26	-0.0469
Higher secondary (%)	4.61	21.01	6.56	24.86	2.11	14.43	-0.0445
Tertiary (%)	1.84	13.48	3.28	17.88	0	0	-0.0328
Number of lactating cows	17.8	8.36	17.43	6.85	18.27	9.98	0.847
Land size (ha)	3.69	2.71	3.8	3.01	3.55	2.28	-0.256
N	217		122		95		217

Note that: Distance to market is the farmers' distance to the closest informal(open-air) market. We use data on the number of lactating cows as a proxy for herd size. All the dairy farmers are also involved in arable crop farming, and the variable land size is the size of land farmers use to cultivate arable crops *** p<0.01, ** p<0.05, * p<0.1
Source: authors

Table 1: Summary of farmers' characteristics in wave 1.

	Participants	Non-participants	diff
Average dairy income per year in USD ($)			
Wave 1	586.89	426.10	-160.82***
Wave 2	682.27	349.84	-332.43***
Diff	-95.38***	76.23**	
Average yield (litres/day/cow)			
Wave 1	1.96	1.76	-0.21***
Wave 2	1.97	1.79	-0.19***
Diff	-0.01	-0.03*	
N	122	95	217

Note that: diff shows the difference between participants and non-participants while Diff shows the difference between waves 1 and waves 2 for participants and non-participants. 1 naira = 0.00328 US dollar (CBN, 2017). *** p<0.01, ** p<0.05, * p<0.1
Source: authors

Table 2: Summary statistics of farmers dairy yield and income.

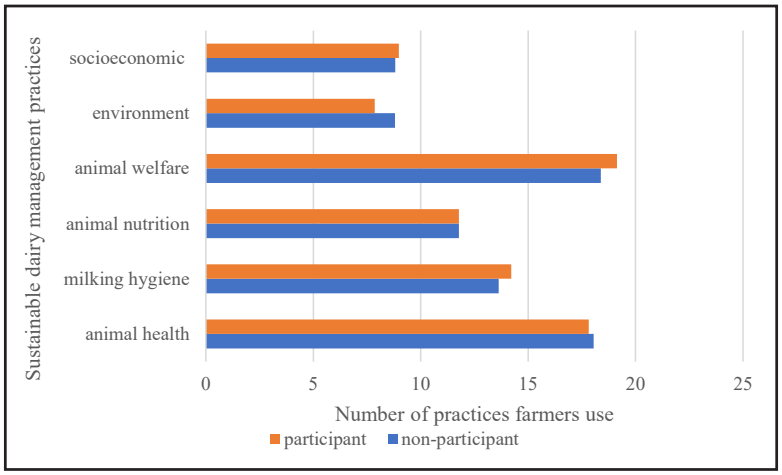
The participants earn, on average, about 30% more annual dairy income than the non-participants. The explanation for this is that participants have access to reliable markets all year round through the FrieslandCampina MCCs. Also, the average litre of milk produced per cow per day for participants is about 10% higher than that of the non-participants. The average yield by non-participants is in line with Mrode (1988) and Michael et al. (1991). Participants' use of higher-yielding cow for milk production may also be related to the higher income earned compared to the non-participants. The FrieslandCampina programme has introduced farmers to other improved farming methods and has linked farmers to suppliers of high quality(veterinary) products. Participants access to these services may explain the higher yield per cow compared to non-participants. The participants also seem to be better off in wave 2 than wave 1, suggesting that farmers are getting better with time as they are more familiar with the business arrangement facilities and services introduced to them by the programme.

Sustainable dairy management practices

Figure 5 shows a summary of the number of sustainable dairy management practices farmers use in dairy production. The horizontal axis indicates the number of practices, and the vertical axis shows the six dimensions of sustainable dairy management practices (FAO, 2011). Of all the dimensions, participants and non-participants are only statistically different for the average number on sustainable milking hygiene and environmental management practices used. Both groups of farmers use an average of 79 out of the total (95) sustainable dairy management practices we explore.

However, participants use more sustainable milking hygiene practices compared to non-participants. Such milking hygiene practices include appropriate udder preparation before milking and the use of clean water on the farm. Using milking hygiene practices seem more important to participants than non-participants because participants who fail to use such practices fall at the risk of getting their milk rejected at the MCC. The quality of milk is tested at the MCC before it can be accepted, and only farmers with good quality milk will be paid. Non-participants, on the other hand, may not have to take as much precaution since they sell in the open market, where milk quality and safety are often not considered by the buyers. Surprisingly, non-participants employ more sustainable environmental practices on their farm compared to participants. Examples of such practices include minimising the production of environmental pollutants and recycling farm waste. It is important to note that the magnitude of difference in average for the two dimensions (milking hygiene and environment) are small, albeit less than 1 unit; hence we are cautious in explaining the results further.

We give examples of indicators for each of the other dimensions, although not significantly different between the participants and the non-participants. Sustainable animal health practices farmers employ include vaccination of all animals and attending to sick animals quickly and appropriately. Sustainable animal nutrition practices include meeting the nutritional needs of animals and using different equipment for handling chemicals and feed. Animal welfare practices include using buildings and handling facilities that are free of obstructions



Source: authors

Figure 5: Summary of farmers' use of sustainable dairy management practices.

and hazards and protecting animals from adverse weather conditions. Socio-economic management practices include ensuring farm workers and staff carry out their tasks competently and ensuring the farm working environment complies with relevant occupational health and safety requirements.

Programme participation and farmers' welfare

First, we explain our result for hypothesis 1, FrieslandCampina DDP has a positive effect on participating farmers' welfare, using a pooled OLS method (see Table 3). Columns 1 and 2 show the effect on farmers' dairy income, while columns 3 and 4 show the yield effect. However, in columns 1 and 3, we do not include a control for the six dimensions of sustainable dairy management practices.

We see that our hypothesis is true for the two outcome measures. Participation in the DDP increases farmers' income and yield by about 67% and 11%, respectively, that is before controlling for the number of sustainable dairy management practices farmers use. However, excluding the variables accounting for sustainable dairy management practices may lead to omitted variable bias (Wooldridge, 2013). As mentioned earlier, the number of sustainable dairy management practices farmers use has a welfare effect on the farmers. Hence, we will only focus on interpreting the results presented in columns 2 and 4.

After controlling for the number of sustainable dairy management practices farmers use, results show that participation in the DDP increases farmers' dairy income and yield by about 79% and 7%, respectively (more precise estimates than in columns 1 and 3). This result is not surprising, and the estimates support our descriptive statistics in Table 2. The explanation for the programme effect on dairy income is that participants have access to reliable markets all year round through the FrieslandCampina MCCs. This result is in line with the DDP aim of improving farmers welfare. Also, an assessment of a similar programme, SDCP, in Kenya (Bonilla et al., 2018) shows that development programmes targeted at providing market access and improving farmers participation will, in turn, improve farmers welfare.

The participants sell their products during the rainy season when there is usually a glut due to increased milk yield and excess milk supply. The non-participants, on the other hand, will have to either contend with wastage of their products or sell at a reduced price, lower than the price offered by the MCC -the price in the informal (local commercial) market is usually lower than prices at the MCC during the rainy season. During the dry season, cattle are less productive (yielding), and the milk supply is limited (Nguyen et al., 2019), and the price in the local markets is always higher than the price offered by the MCC. Participants may then choose to sell part of the milk produced in the open market and sell another part to the MCCs, thereby taking advantage of the price in the informal market. This is, however, possible because the business agreement between the farmers and the agribusiness firm, which is informal and flexible, especially regarding the quantity of milk farmers may supply

Variables	-1	-2	-3	-4
	Dairy Income		Yield	
Participate (1=yes)	0.669***	0.790***	0.110***	0.077*
	-0.117	-0.246	-0.02	-0.042
Distance to MCC (km)	-0.003	-0.004	0	0
	-0.004	-0.004	-0.001	-0.001
Participate x Distance	0.004	0.004	-0.001	0
	-0.005	-0.005	-0.001	-0.001
Sustainable dairy management practice	No	Yes	No	Yes
Animal health practices		-0.010*		-0.003***
		-0.006		-0.001
Participate x animal health practices		-0.001		0.004**
		-0.011		-0.002
Milking hygiene practices		0.035**		0.001
		-0.014		-0.002
Participate x milking hygiene practices		-0.016		0.002
		-0.022		-0.004
Animal nutrition practices		0.004		0.002
		-0.009		-0.002
Participate x animal nutrition practices		0.002		-0.003
		-0.014		-0.002
Animal welfare practices		0.006		-0.001
		-0.006		-0.001
Participate x animal welfare practices		-0.012		0
		-0.011		-0.002
Environmental practices		-0.023		0
		-0.015		-0.003
Participate x environmental practices		0.03		-0.002
		-0.019		-0.003
Socioeconomic management practices		0.001		0.004***
		-0.009		-0.001
Participate x socio-management practices		0.003		-0.002
		-0.014		-0.002
Constant	10.914***	10.670***	0.565***	0.571***
	-0.17	-0.217	-0.029	-0.037
Household characteristics	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes
Observations	434	434	434	434
R-squared	0.782	0.789	0.649	0.671

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors

Table 3: OLS estimates of programme participation on farmers' dairy income and yield.

to the MCC. This result is in line with Erba and Novakovic (1995), who note that because milk is a perishable commodity, it could not be stored to make seasonal gains and to balance out the seasonal variations in supply and demand for milk. However, the DDP offers participant farmers opportunities to make gains due to seasonal variations.

For effect on yield, the programme is specifically targeted at improving the yield of participating farmers by providing the farmers with training

on how to produce high quality and increase milk supply and by linking farmers to high-quality input suppliers (Köster and de Wolff, 2012). Increased yield can, in turn, increase the income participants earn from dairy production compared to the non-participants.

However, the caveat here is that dairy income is not the only income source for many Fulani farmers. The farmers are often involved in other income-generating activities like arable crop farming, beef production, and petty trading. We note that the result from Table 3 may not indicate the overall welfare effect on the farmer, but welfare as it relates to milk production only. Also, as mentioned earlier, there are other unobserved characteristics, like farmers' ability and cattle characteristics, that we do not account for. However, the findings in Table 3 provide a simple explanation of the programme effect on farmers.

Explaining the other variables besides the programme effect that we present in Table 3. We find that farmers' distance to MCC and its interaction term with farmers' participation status do not significantly affect the farmers' welfare. It suggests that, although farmers distance is linked to their probability of participating in the programme (Holloway et al., 2008), it does not have any welfare effect on the farmer. This supports our argument that farmers generally have other sources of income that may affect their welfare status. We also find that of all the six dimensions of sustainable dairy management practices, only sustainable animal health, milking hygiene, and socio-economic management practices are statistically significant welfare effects on farmers. The number of sustainable animal health practices farmers use reduces farmers' dairy income and yields by 1% and 0.3%, respectively. The results suggest that, although farmers may be using many animal health practices and probably spending a lot of their income in maintaining these practices, some farmers may be using the practices wrongly. Hence, the negative effects on income. However, participation in DDP and the use of sustainable animal health practices increase farmers yield by 0.4%. The number of sustainable milking hygiene practices farmers use also have a positive relationship (3.5%) with dairy income, while the number of sustainable socio-economic management practices farmers use has a positive relationship (0.4%) with yield.

Mechanism of programme effect

We explore the second hypothesis that the mechanism of programme effect is through participants' use of sustainable dairy management practices, in particular, through farmers' use of sustainable milking hygiene and animal health practices. Table 4 shows the negative binomial regression results to test our hypothesis, and the first column shows the programme effect on the total number of sustainable dairy management practices farmers use. Columns 2 to 7 show the programme effect on each sustainable dairy management practices dimensions we explained earlier.

Contrary to what we expect, we find that programme participation has no statistically significant effects on farmers use of sustainable dairy management practices. We note that although the programme has positive effects on farmers' welfare, we cannot ascertain that the use of sustainable dairy management practices is the mechanism of programme effect. This result is contrary to our apriori expectation that farmers welfare is improved by adopting sustainable dairy management practices (Gelan and Muriithi, 2015; Bonilla et al., 2018). We note that other factors like investment in productive assets, which we do not cover in our study, maybe a mechanism of programme effect.

We note that it could be that the farmers were also already using sustainable dairy management practises before the programme, and the numbers of practices farmers use may not be linked to their participation status. We cannot verify this claim since we do not have baseline data. We also note that the null results in Table 4 may be attributed to other measurement errors, like our measure of use of sustainable dairy management practices, which is by counting the numbers of practices farmers use. We do not account for the extent and intensity of use or the duration of use of these practices. We note that the degree of use of these practices may vary greatly between farmers. We also attribute our result to our inability to control for unobservable characteristics such as farmers ability to use these practices.

VARIABLES	Total	Animal health	Milking hygiene	Animal nutrition	Animal welfare	Environment	Socioeconomic
Participate (1=yes)	-0.074	-0.145	0.000	-0.156	0.120	-0.189	-0.216
	(0.108)	(0.162)	(0.186)	(0.202)	(0.161)	(0.240)	(0.233)
Distance to MCC (km)	-0.002	-0.006	-0.001	-0.005	0.004	0.001	-0.006
	(0.004)	(0.006)	(0.007)	(0.007)	(0.006)	(0.009)	(0.009)
Participate x Distance	0.004	0.007	0.002	0.008	-0.003	0.003	0.008
	(0.005)	(0.007)	(0.008)	(0.009)	(0.007)	(0.011)	(0.010)
Constant	4.547***	3.245***	2.685***	2.606***	2.912***	2.339***	2.518***
	(0.159)	(0.237)	(0.274)	(0.296)	(0.236)	(0.348)	(0.343)
Alpha (α)	.0122665***	1.92e-10	4.40e-11	8.71e-16	3.31e-10	9.65e-14	6.85e-13
Observations	217	217	217	217	217	217	217

Note: Alpha (α) is overdispersion parameter Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Source: authors

Table 4: Negative binomial coefficient estimates of programme participation on farmers' use of sustainable dairy management practices.

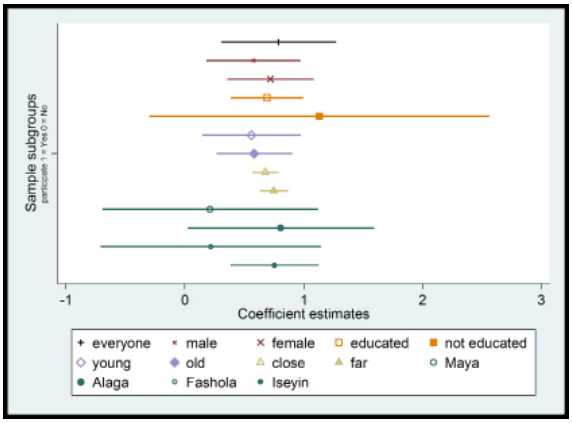
Subgroup analyses

Although from Table 4 we find that programme participants are on average better off than non-participants. We carry out subgroup analyses and group our sample according to their socio-economic characteristics: sex, education, age, distance to MCC, and location (MCC). We then test our third hypothesis; programme effects vary among participants and non-participants within the same socio-economic group. We focus on only the effect on dairy income. Figure 6 shows the plot estimate of the subgroup analyses. The horizontal axis shows the magnitude of the coefficient estimates of programme effect, the magnitude of the effect of participation on income for various restricted groups of the sample.

We find that programme participation increases income by 57.6% among the male farmers, while among the female farmers, programme participation increases income by 72.1%. The result suggests that the programme effect is wider among female farmers than among male farmers. The explanation for this is that male non-participants may be better off than female non-participants. Since female farmers are considered vulnerable, the programme offers female participants an opportunity to improve their welfare status.

We also note that the difference in programme effect between participants and non-participants increases with distance to the MCC (Barrett et al., 2012; Edirisinghe and Holloway, 2015). That is, regardless of farmers' age, sex, and education level, participants located within a 20km radius of any MCC are better off (67.9% higher income) than non-participants within the same radius. And among farmers residing far away from the MCC, programme participation increases farmers income by about 75%. The interpretation is that among eligible farmers residing farther away from the MCC, the farmers who choose to participate in the programme are better off than their peers but do not participate. The effect is wider when compared with the group of farmers residing close to the MCC.

Also, for farmers residing around Maya or Fashola MCC, the effect of programme participation on dairy income is not significantly different between the participants and non-participants. However, programme effect on the welfare of farmers around Alaga and Iseyin MCC are significantly different and significant.



Source: authors

Figure 6: Coefficient plot estimates of subgroup analyses showing the effect of programme participation on dairy income.

Conclusion

In summary, we use a two-wave survey of dairy farmers in Oyo State, Nigeria to explore the effects of FrieslandCampina Dairy Development Programme on farmers' welfare. We focus

on Fulani dairy farmers located around each of the four MCCs set up by FrieslandCampina to collect raw milk from the farmers. It is important to note that our study is limiting. We could not explore the cost-benefit partition of farmers' participation in the dairy markets as in Ngeleza and Robinson (2013). We note that such analysis can provide further insight into the effects of the FrieslandCampina Dairy Development Programme. However, we note that farmers find it hard to recall information related to cost and revenue. Hence, we take a wide-ranging approach that the data allow, following the methods and features that prior research has identified to be important.

We focus on two outcome measures that are indicators of dairy farmers' welfare status - annual dairy income and daily milk yield. We employ pooled ordinary least squares estimates to show the programme effects on farmers. We control for other observable characteristics like age, sex, education and distance to market and MCCs. We also analyse the mechanism of programme effect on farmers' welfare by exploring the programme effect on farmers' use of sustainable dairy management practices. We employ a negative binomial regression model and focus on programme effects on the total number of sustainable dairy management practices farmers use. We further explore the programme effects on each of the six main dimensions of sustainable dairy management practices identified by FAO (2011). Finally, we explore sub-group analyses focusing on farmers socio-economic characteristics like sex, ad, education, distance and location. The sub-group analyses help us to understand the heterogeneous effect of the programme on farmers welfare.

While there is a long history of investment intended to boost rural welfare and develop the local dairy sector through various agricultural and rural development policies, our findings reinforce the continued need to support rural farmers through the provision of reliable market access. The Federal Government should implement similar policies like the Local Content Act or strengthen the existing policy to encourage other agro-processing firms to set up similar development programmes around the country. Such policies may also be targeted at encouraging the involvement of private firms in rural development, strengthening the synergy between the local producers and the agro-processors.

As part of the global effort to develop the rural and agricultural sector in sub-Saharan Africa, the European Union and other developed economies may implement development policies targeted at the rural dairy sector. Moreover, multinational firms in Europe and other developed countries sourcing milk products to meet the global demand may adopt the dairy development programme to tap into the rural dairy value chain in sub-Saharan Africa. Such programmes will help get the local milk products to the global market and help address the poverty rate in sub-Saharan Africa.

Other agro-processing firms seeking to set up similar programmes, especially in the dairy sector, may also adopt the 30km eligibility rule for programme participation. However, non-participants leaving are away from the milk collection sites should be encouraged to participate in the programme as such farmers will be better off participating than when they are not participating. FrieslandCampina may also offer milk pick up services to non-participants to encourage programme participation.

FrieslandCampina should embed a farmer literacy programme and encourage non-participants, especially those with no formal education, to participate. The government should invest in infrastructural facilities such as schools, good road networks and potable water sources. Such infrastructural facilities are important to ensure farmers use of sustainable dairy management practices. The firm should also intensify training on the appropriate use of animal health, milking hygiene and socio-economic management practices. The use of such practices has significant effects on rural dairy farmers welfare status.

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References

[1] Arouna, A., Michler, J. and Lokossou, J. C. (2019) "Contract Farming and Rural Transformation: Evidence from a Field Experiment in Benin", NBER Working Papers 25665, National Bureau of Economic Research, Inc. DOI 10.3386/w25665.

[2] Barrett, C., Bachke, M. E., Bellemare, M., Michelson, H., Narayanan, S. and Walker, T. F. (2012) "Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries". *World Development*, Vol. 40, pp 715-730. ISSN 0305-750X. DOI 10.1016/j.worlddev.2011.09.006.

[3] Bayer, W. and Kapunda, L. (2006) "Dairy cattle for poverty alleviation in Southern Tanzania", At *Conference on International Agricultural Research for Development, University of Bonn*, 11–13 October 2006. DOI 10.2307/j.ctv16zjjh3.8.

[4] Bonilla, J., Mccarthy, N., Mugatha, S. M., Rai, N., Coombes, A. and Brubaker, J. (2018) "*Impact evaluation of the smallholder dairy commercialisation programme in Kenya*". [Online]. Available https://www.3ieimpact.org/sites/default/files/2019-01/IE73-Kenya-dairy-commercialization.pdf [Accessed 24 Feb. 2020]. DOI 10.23846/tw4IE73.

[5] Burke, W. J., Myers, R. J. and Jayne, T. S. (2015) "A Triple-Hurdle Model of Production and Market Participation in Kenya's Dairy Market", *American Journal of Agricultural Economics*, Vol. 97, pp. 1227-1246. ISSN 0002-9092. DOI 10.1093/ajae/aav009.

[6] CBN (2017) "*Monthly Average Exchange Rates of the Naira(Naira Per Unit of Foreign Currency) – 2017*". [Online]. Available: https://www.cbn.gov.ng/rates/exrate.asp?year=2017 [Accessed: 24 Feb. 2020].

[7] Edirisinghe, J. C. and Holloway, G. J. (2015) "Crossbred cow adoption and its correlates: Countable adoption specification search in Sri Lanka's small holder dairy sector", *Agricultural Economics*, Vol. 46, No. S1, pp. 13-28. ISSN 0169-5150. DOI 10.1111/agec.12195.

[8] Ekumankama, O., Ezeoha, A. and Uche, C. (2020) "The role of multinational corporations in local dairy value chain development: case of Friesland Campina WAMCO (FCW) in Nigeria", *International Food and Agribusiness Management Review*, Vol. 23, No. 1, pp. 55-70. ISSN 1559-2448. DOI 10.22434/IFAMR2018.0108.

[9] Erba, E. M. and Novakovic, A. M. (1995) "*The Evolution of Milk Pricing and Government Intervention in Dairy Markets", Cornell University, Department of Applied Economics and Management. [Online]. Available*: https://ecommons.cornell.edu/handle/1813/68878 [Accessed: 24 Feb. 2020].

[10] FAO (2011) "Guide to Good Dairy Farming Practice, Food and Agriculture Organization of the United Nations". [Online]. Available: http://www.fao.org/3/ba0027e/ba0027e00.htm [Accessed 24 Feb. 2020].

[11] Gelan, A. and Muriithi, B. (2015) "Examining Returns to Scale in Smallholder Dairy Farms in East Africa", *Quarterly Journal of International Agriculture*, Vol 54, No. 3, pp. 239 - 261. ISSN 0049-8599. DOI 10.22004/ag.econ.225952.

[12] Glover, D. J. (1984) "Contract farming and smallholder outgrower schemes in less-developed countries", *World Development*, Vol 12, No. 11-12, pp. 1143-1157. ISSN 0305-750X. DOI 10.1016/0305-750X(84)90008-1.

[13] Holloway, G., Ehui, S. and Teklu, A. (2008) "Bayes Estimates of Distance-to-Market: Transactions Costs, Cooperatives and Milk-Market Development in the Ethiopian Highlands", *Journal of Applied Econometrics*, Vol. 23, pp. 683-696. ISSN 08837252. DOI 10.1002/jae.1019.

[14] Holloway, G., Nicholson, C., Delgado, C., Staal, S. and Ehui, S. (2000) "Agroindustrialization through institutional innovation: Transaction costs, cooperatives and milk-market development in the east-African highlands", *Agricultural Economics*, Vol. 23, No. 3, pp. 279-288. ISSN 0169-5150. DOI 10.1016/S0169-5150(00)00089-X.

[15] Ilu, I., Frank, A. and Annatte, I. (2016) "*Review of the livestock/meat and milk value chains and policy influencing them in Nigeria*", Published by the Food and Agriculture Organization of the United Nations and the Economic Community of West African States, pp. 1-34. [Online]. Available: http://www.fao.org/3/i5259e/i5259e.pdf [Accessed 24 February 2020].

[16] Knips, V. (2005) "Developing countries and the global dairy sector part I global overview", PPLPI Working Papers 23768, Food and Agriculture Organization of the United Nations, Pro-Poor Livestock Policy Initiative.

[17] Köster, H. W. and De Wolff, J. (2012) "Dairy development programme in Nigeria baseline report: Key Findings and recommendations", Alabama: IFRC. DOI 10.22004/ag.econ.23768.

[18] Leister, A. M., Lee, J. G. and Paarlberg, P. L. (2016) "Dynamic effects of drought on the US livestock sector", *Agricultural and Resource Economics Review*, Vol. 45, No. 3, pp. 459-484. E-ISSN 2372-2614, ISSN 1068-2805. DOI 10.1017/age.2016.4.

[19] Meemken, E.-M. and Bellemare, M. F. (2020) "Smallholder farmers and contract farming in developing countries", In *Proceedings of the National Academy of Science*s, Vol. 117, pp. 259-264. [Online]. Available: https://www.pnas.org/content/pnas/117/1/259.full.pdf [Accessed: 25 Feb. 2021].

[20] Michael, W., Grindle, J., Nell, A. and Bachman, M. (1991) "Dairy development in sub-Saharan Africa: A study of issues and options", *Africa Technical Department Series No. 135*. World Bank Technical Paper, Washington, DC, pp. 27-209. [Online]. Available: http://documents1.worldbank.org/curated/en/397001468768281624/pdf/multi-page.pdf [Accessed: 20 Feb. 2020].

[21] Michelson, H., Boucher, S., Cheng, X., Huang, J. and Jia, X. (2017) "Connecting supermarkets and farms: The role of intermediaries in Walmart China's fresh produce supply chains", *Renewable Agriculture and Food Systems*, Vol 33, pp. 47-59. E-ISSN 1742-1713, ISSN 1742-1705. DOI 10.1017/S174217051600051X.

[22] Mrode, R. A. (1988) "Lactation performance of the White Fulani cattle in southern Nigeria", *Tropical Animal Health And Production*, Vol. 20, pp. 149-154. ISSN 0049-4747. DOI 10.1007/BF02240083.

[23] Ngeleza, G. K. and Robinson, E. J. (2013) "Cartels and Rent Sharing at the Farmer–Trader Interface: Evidence from Ghana's Tomato Sector", *Journal of Agricultural and Food Industrial Organization*, Vol. 11, No. 1, pp. 15-30. ISSN 1542-0485. DOI 10.1515/jafio-2012-0011.

[24] Nguyen, T. P. L., Seddaiu, G. and Roggero, P. P. (2019) "Declarative or procedural knowledge? Knowledge for enhancing farmers' mitigation and adaptation behaviour to climate change", *Journal of Rural Studies*, Vol. 67, pp 46-56. ISSN 0743-0167. DOI 10.1016/j.jrurstud.2019.02.005.

[25] Setboonsarng, S. (2008) "Global partnership in poverty reduction: Contract farming and regional cooperation", ADB Institute Discussion Papers. [Online]. Available: https://www.econstor.eu/handle/10419/53517 [Accessed: 24 February 2020].

[26] Singh, S. (2002) "Contracting out solutions: Political economy of contract farming in the Indian Punjab", *World Development*, Vol. 30, No. 9, pp. 1621-1638. ISSN 0305-750X. DOI 10.1016/S0305-750X(02)00059-1.

[27] Stiglitz, J. E. (1989) "Markets, market failures, and development", *The American Economic Review*, Vol. 79, pp. 197-203. ISSN 0002-8282.

[28] Wooldridge, J. M. (2013) "*Introductory Econometrics: A Modern Approach*", 7th ed., Cengage Learning. ISBN 13 978-1-305-27010-7.

[29] Yahuza, M. (2001) "Smallholder dairy production and marketing constraints in Nigeria. Smallholder dairy production and marketing—Opportunities and constraints", In: *Proceedings of a South–South workshop held at National Dairy Development Board (NDDB) Anand, India*, 13–16 March 2001. pp. 201-214. [Online]. Available: https://cgspace.cgiar.org/bitstream/handle/10568/16607/SS_Proceeding.pdf?sequence=1 [Accessed: 24 Feb. 2020].