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## AGROSILVICULTURE AS A STRATEGY FOR ENVIRONMENTAL CONSERVATION AND SUSTAINABLE PEACE IN SUDANO-SAHELIAN ZONE OF NORTHERN NIGERIA

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### ABSTRACT

Sudano-Sahelian zone of Nigeria has a history of meeting the demands of both the human and livestock population with food and fodder supplies. However, growing human population in recent time coupled with climate change has brought keen competition for the control of land resource between crop farmers and pastoralists, resulting to conflicts which in most cases end in loss of life and property, rapid reduction of fodder and crop, low productivity of land and general poverty. Approach to stem these phenomena is application of agro-forestry systems to improve soil fertility. This study was conducted in three northern states of Borno, Jigawa and Sokoto to proffer agroforestry as one of the solutions to the problem in the area. Purposive and random sampling procedures were used to select 10 communities from where 310 respondents were select rural communities and respondents, respectively. Data collected was analyzed using descriptive statistics (frequency distribution, means and percentages). Deforestation of economic trees on their farmland was the major cause of the conflicts in the area. The farmers were aware of dwindling trend of crops, fodder and other vegetal resources over the years. Natural forest had dwindled by 37.3%, shrubs and grass by 11.5% and water by 26.9%. Also, they were aware of potentials of agro-forestry practices to improve crop and fodder production in the area. Some 37.3% stated soil erosion control, 21.9% reported as a mean of wind break and 11% pointed that agroforestry conserves groundwater. Therefore, it was recommended that state government should strictly enforce deforestation laws to minimize pressure on land resources, and sensitise and educate farmers on wood production for their various uses in the area.

**Keywords:** Agro-forestry, Livestock Fodder, Pasture degradation, Sudano-Sahelian zone.

### INTRODUCTION

Sudano-Sahelian zone of Nigeria is a zone between latitudes  $12^{\circ}00'$  and  $14^{\circ}00'$  north. It stretches from Borno State in the north-east to Sokoto State in north-west. The zone is characterized by erratic rain fall, sandy soils, sand dunes and thorny vegetation. Arable agriculture, transhumance and nomadic grazing are the main forms of land use in the zone (Nianogo and Thomas, 2004).

The landscape in the zone reveals a large expanse of dusty land punctuated by occasional cluster of grass, shrubs and a few buttress trees (Upah, 1987). Sudano-Sahelian zone of Nigeria has an important role in animal production but has been in continuous deterioration due to over cropping and grazing. The zone has almost lost its land productivity and land degradation has been conspicuous. The degradation constitutes a serious threat to peace and tranquillity among the inhabitants as well as the environmental conditions, hitherto food and fodder production become serious problems. The zone has an estimated 67,000 hectares of land for arable farming which is currently under threat of desertification. Sudano-Sahelian Nigeria is constantly shrinking in terms of pasture land by crop farming and this situation calls for environmental management to forestall its initial conditions based on agroforestry technologies which seem to offer immediate solution. Under agroforestry systems, farmers can grow their food and fodder crops on his parcel of land.

However, farmers in the zone are yet to adopt full package of agrosilviculture agroforestry

as majority of them use natural pasture for grazing. This practice often ends in conflict and crisis, especially in recent times, leading to mass violence during the recurrent insurgency in the zone where large landmass that would normally have been under crop cultivation and grazing was locked up by the insurgents. Crop farmers and pastoralists then concentrate on the limited land for farming and grazing, thereby exerting more pressure on land beyond possible recovery from the overuse. When such situation occurs, animals are forced to eat any available vegetation they see resulting to unproductive herding. Other small animals, such as sheep and goats graze on the remaining grasses, browse shrubs and trees ruthlessly. More often, pastoralists compound the situation by lopping off leaf-bearing branches and sometimes chopping down the entire trees for animal feeding (Oladipo, 2013). emphasis should be placed More so, general emphasis among the population in the Sudano-Sahelian zone is placed on food crop production, not on pasture production and so livestock are relegated to background.

Resources Inventory and Management (RIM) (2013) puts the population of cattle at 15 million, 34 million goats, 24.5 million sheep, 82 million chickens, 34 million other types of poultry, 3.5 million pigs, 1.7 million, domesticated rabbits, 0.94 million donkeys and 0.29 million constitute other types of livestock not mentioned. Over 80 percent of this population is found in the Sudano-Sahelian zone of the country (NLPD, 2005) which is located in the area of acute fodder shortage. This is an indication of a tremendous pressure on the available pastoral land of the zone. Agro-forestry

agrosilviculture practice which combines raising of trees, crop production and livestock rearing by a farmer has the capacity to reduce the crisis in the Sudano-Sahelian zone of Nigeria by bringing the three components under his farm holding. Therefore, the objectives of this study were to: identify types of livestock kept by farmers, pasture sources, status of pasture, change in land and vegetation resources, causal agents and potentiality of agro-forestry to stabilize the land resources and peaceful co-existence among crop farmers and livestock rearers in Sudano-Sahelian zone.

### METHODOLOGY

The study area is the Sudan-Sahelian States of Borno, Jigawa and Sokoto States of Nigeria located in northern Nigeria between latitude  $10^{\circ}\text{N}$  and  $14^{\circ}\text{N}$  and longitude  $4^{\circ}\text{E}$  and  $14^{\circ}\text{E}$ . This zone occupies almost one-third of the total land area of the country.

The sampling frame for the study comprises both crop and livestock farming households in the five Local Government Areas (LGAs) each from Borno, Jigawa and Sokoto States. Primary data backed up by secondary data were used for this study. Two stage sampling technique was used in selecting the study area and sampled respondents. Purposive and random sampling techniques were used to select the study area and respondents. The first stage involved the purposive sampling of the three Sudano-Sahelian States of Borno, Jigawa and Sokoto due to the presence of aridity and agroforestry practices, from where five local government areas were randomly selected from each state. Simple random sampling was used to select the states and local government areas. Five local government areas were selected from Borno State, which are Kukawa, Damasak, Monguno, Benishiek and Ngala. The LGAs from Jigawa State included Kirikasama, Rigm, Kazaure, Babra and Roni. The Local Government Areas

selected from Sokoto State was Illela, Sabon Birni, Isa, Kwari and Goronyo. In the second stage, random sampling technique was employed to select 102 respondents from Borno State, 98 respondents from Jigawa State and 110 respondents from Sokoto State. Thus, a total of 310 respondents were randomly selected for the study.

Descriptive statistics, mainly frequency distribution and percentage were used to analyse the data.

### RESULTS AND DISCUSSION

#### Cropping Pattern in Sudano-Sahelian Zone of Nigeria

The pattern of crops produced in the zone is shown in Table 1. The pattern shows that millet is produced by 43.6%, sorghum by 21.9%, rice by 13.6% and cowpea by 30.0%. Other important crops produced in the area included groundnut by 3.6%, melon 1.8%, beniseed 1.3% and other non important crops, such as Bambara nut and pumpkin by 1.2%. Millet, sorghum and cowpea were the principal crops since all farmers cultivate them. Groundnut and rice are produced as cash crops in the area. Rice production is restricted to areas fed by major and minor rivers in the area. Beniseed and melon were regarded as minor crops and only a few farmers cultivate them. The Sahelian droughts of the 1970s and the 1980s ravaged this zone and left farmers impoverished (Ati *et al.*, 2007). It has also been noted that the frequent occurrences of drought in this zone is responsible for the social backwardness and general poor quality of life especially among the less privileged ones (Alatise and Ikumawoyi, 2007). The situation is being aggravated by the increase in human population, which appears to be stressing the natural support system (FRN, 2005) and by implication resulting to competition between different groups of land users in the Sudano-Sahelian zone.

**Table 1: Distribution of Respondents by Cropping Pattern**

Crops	Frequency of Farmers	Percent
Millet	135	43.6
Sorghum	68	21.9
Cowpea	40	30.0
Rice	42	13.6
Groundnut	11	3.6
Beniseed	4	1.3
Melon	6	1.8
others	4	1.2
<b>Total</b>	<b>310</b>	<b>100.0</b>

#### Livestock Pattern of the Farmers

Table 2 shows that all the farmers kept one or more livestock types ranging from cattle to poultry. The pattern of livestock ownership showed that all the 310 (100%) respondents owned cattle, sheep, goat and poultry in different number. This

was closely followed by horses which were kept by 33.8% of farmers, while camels were kept by 24.8% and donkeys were kept by 21.4% of the farmers. Only farmers with smaller livestock holdings (1-10) seemed to have kept horses, camels and donkeys. Farmers with livestock holdings above 50

did not keep any of the camels. This is because equines and camels were means of burden in the area and farmers with larger livestock holdings can afford other motorized means for farm work or transportation. In terms of number, 45% of the farmers preferred to keep large herds of cattle ranging between 91 and above. Poultry forms an important component of all categories of holdings but more so with rage below 40. The findings showed the importance of cattle as a source of wealth while poultry is for meeting the ceremonial need of the farmers. Farmers who kept a few

number of livestock stated that fodder scarcity and prohibitive prices of larger animals such as cattle and camels could not warrant them to keep large number of animals. It is however, interesting to note that cattle, sheep and goats which are responsible for land degradation were owned by all categories of livestock holdings by farmers. Thus, both arable and pastoralists are engaged in livestock rearing, this implied that agroforestry practices can foster peace by engaging farmers to produce fodder and fuel wood for their use.

**Table 2: Distribution of Respondents by Livestock kept (n=310)**

Range of Livestock*	Cattle	Sheep	Goats	Donkeys	Horses	Camel	Poultry
01-10	3.3	3.8	2.4	82.2	94.4	98.1	2.9
11-20	4.3	5.9	14.3	15.6	0.0	2.0	5.9
21-30	2.4	4.8	9.1	2.2	2.8	0.0	53.8
31-40	2.9	5.2	10	0.0	9.1	0.0	0.0
41-50	1.4	19.0	12.9	0.0	2.8	0.0	0.0
51-60	9.5	23.8	10	0.0	1.0	0.0	3.3
61-70	10.5	9.5	19	0.0	2.9	0.0	0.0
71-80	4.3	13.3	5.3	0.0	1.9	0.0	0.0
81-90	15.7	5.2	5.9	0.0	2.9	0.0	0.0
91-100	24.3	5.9	4.3	0.0	6.7	0.0	0.0
>101	21.0	3.8	3.3	0.0	10.0	0.0	0.0

\*Multiple responses

#### Sources of pasture in the area

Table 3 shows the major sources of pasture in the area. Natural pasture is the main source of feed as reported by 100% of the respondents followed by crop residues (19.5%). Many areas of Sudano-Sahelian zone of Nigeria are unsuitable for arable crop production because of highly variable and unpredictable rainfall as well as poor soil fertility. Such conditions made ruminant production as another alternative in the face of a great mobility, as herders and their livestock in such areas wander freely. However, the stocking rate of livestock in the area exceeds the carrying capacity of the land, forcing the herders to periodically leave their villages to the more humid south during the dry periods and back to the base in the north during wet season. Herders then move the herds to cultivated areas after grain harvest in order to take advantage of the crop residues.

Decreased availability of arable land and the need to diversify income and improve soil fertility have helped to promote mixed crop-livestock integration. Manure from the animals are composted and used to fertilize cereal fields, especially for farmers without access to chemical fertilizers as commonly found in the area, while crop residues are preserved and stored to feed ruminants, especially during the dry months. A few, 5.7% supplemented their animal feed with purchased residues and concentrates, particularly during the long dry season. These categories of farmers are the nomadic group who do not practice integrated mixed crop-livestock system. Nomadic herders usually access crop residues at payment of certain token of money to crop farmers. There were 5.5% farmers who rely solely on purchased residues. This category of farmers are mainly the traders who were in the business of fattening rams and bulls for profit especially during major feasts such as *Sallah* (the Muslim *Eid el Kabir*).

**Table 3: Distribution of Respondents by Sources of Fodder for Livestock**

Source	Frequency	Percent
Natural pasture	310	100*
Crop residues	14	19.5
Purchased feeds only	11	5.5
Natural pasture/purchased feed	12	5.7

### Perception of Agrosilviculture as Environmental Conservation and Peace Management

Farmers in the zone knew the importance of agrosilviculture as a means of environmental conservation, source of fodder, food and poles for construction. Table 4 shows that all (100%) the farmers in the zone plant trees and shrubs on their

farmland for different purposes. They indicated the benefits they enjoy from such practices as soil conservation (35.3%), for peaceful co-existence (19.0%), fodder (13.3%), medicinal purposes (10.0) and food (9.6%). Trees are prerequisites to the survival of Sudano-Sahelian zone of northern Nigeria.

**Table 4: Distribution of Respondents by Benefits of Agrosilviculture**

Benefits	Frequency	percent
Soil conservation	109	35.3
Peaceful co-existence	59	19.0
Fruits	30	9.5
Food	30	9.6
Medicine	31	10.0
Shade	10	3.3
Fodder	41	13.3
<b>Total</b>	<b>310</b>	<b>100.0</b>

### Changes in land use and vegetation in Nigeria

Changes in land use pattern and vegetation in Nigeria at two different periods (i.e. 1986/89 and 2013/15) was reported by National Bureau of Statistics (NBS) and presented in Table 6. The study showed increase in arable crop land area by 1.6% to 8200Km<sup>2</sup>, while the natural forest decreased by 83,000Km<sup>2</sup> (35.4%). Also, built up areas had increased by 3,300Km<sup>2</sup>, while shrubs and grassland decreased by 16,000Km<sup>2</sup> (11.5%). The study revealed that additional degraded areas had increased by 23,000Km<sup>2</sup> (808.4%) in 2005. This is a challenge to afforestation programme of the Federal Government of Nigeria. According to Papka(2005), there was also a decrease of 8,000Km<sup>2</sup> (26.9%) of water bodies, while more land surface and water bodies are being converted for habitation and industrial estates. The study showed that about 3300 Km<sup>2</sup> (158.7%) of the land mass and water bodies in Nigeria have been lost to this purpose. This trend showed that pasture degradation (and indeed general deforestation) of vegetation resources has become prevalent and inimical to livestock development in Nigeria. Reviewing the Land Use and Vegetation Survey of Nigeria conducted in 1996 and the Forest Resource Study of 1998, Papka (2005) stated that a great proportion of the country's estate has been lost to agricultural expansion, annual bush burning, fuel wood and timber extraction, over grazing human activities. Also reported, are the downward shift of desertification from 12°30' to 10°30' and the increase of the sand dunes from 812Km<sup>2</sup> in 1976/1978 to 4,830Km<sup>2</sup> in 2003/2005 (Papka, 2005).

The implications of the changes means more land is being lost to degradation and urban uses annually, leading to low crop production, forest resource depletion on one hand and on the

other hand, high demand for fuel wood, timber and low livestock production due to fodder shortages. Land use conflicts are often aggravated by increasing competition for land as a result of population growth and scarcity of productive land (Kirk, 1999). Momale (2003) reported 11deaths and several hundreds of people injured with properties worth millions of Naira destroyed over land use conflicts between 1987 and 1989 in Hadejia Emirate of Sudano-Sahelian Jigawa State of Nigeria. Attributing this to the scarcity of pasture land and the subsequent ensuing conflicts in the Sudano-Sahelian zone of Nigeria, Ibrahim (2001) indicated that population pressure; economic change and natural hazard in form of recurrent drought in the area have all interacted to reduce land productivity, thereby resulting in competition for and conflict over the use of land. Conflict between crop farmers and herders in the zone exists in two forms: dispute over land ownership and conflict arising from damage to crops by livestock.

Several processes have considerably narrowed the resource base at the disposal of herders in the past few decades. Connected to encroachment into grazing lands, Mortimore (1989) reported that land law makes no special provision for grazing rights. He also observed that increase in crop cultivation; infrastructural development and population explosion as been responsible for the reduction of range land in Nigeria from 67% of the total land in 1951 to 39% in1976; non-agricultural sectors (settlements, roads, airports, etc.) each increased from 1% to 7% during the same period. Similarly, Mohammed (1987) reported that large scale government arable farm projects and technological packages in the semi-arid areas of Nigeria have alienated the bulk of land from both the herders and arable farmers.

**Table 5: Changes in Land use and Vegetation (Km<sup>2</sup>) in Nigeria**

Land use	1986/1989	2013/2015	Percent changes
Arable crops	501,935	595,000	+ 1.6
Natural forest	234,300	151,000	- 35.4
Shrubs/grassland	134,000	17,400	- 11.5
Degraded areas	2,845	26,310	+ 808.4
Built up areas	2,080	5,440	+ 158.7
Water bodies	29,700	20,900	- 26.9

Source: National Bureau of Statistics, 2015

+ = Class increased between 1986/98 and 2013/15

- = Class decreased between 1986/98 and 2013/2015

### Causal Agents of Environmental Degradation

Table 6 shows the farmers' view on the causes of environmental degradation in the area. The entire 310 (100%) respondents stated that deforestation was the main cause of the degradation in the area. Deforestation included cutting down of trees for fodder, food and medicine, firewood and charcoal, poles for construction and for other domestic and industrial uses which have all contributed to the present situation in the area. Already, the vegetation cover of the zone is characterized by feathery grasses interspersed with thorny trees. Oladipo (2013), citing 'World Resources 1990 and 1991 reported that the rate of deforestation in the Sudano-Sahelian zone of Nigeria in the 1980s was of the order of 400,000 hectares yearly, while reforestation was a mere 32,000 hectares which puts the zone at annual deficit of about 360,000 hectares. Optical satellite imagery and field study results conducted by FOMEPU (1999) and reported by Fuwape (2005), indicated that out of the total 983,213Km<sup>2</sup> Nigeria's land mass, the actual land area under forest cover is about 256,938Km<sup>2</sup>, representing 26.13%. Thus, the capacity of forest to meet required fodder and wood supplies has been drastically affected by increased deforestation. Adedoyin (1995), estimated that the total land area designated to forest reserves in the Sudan and Sahel savanna vegetation regions of Nigeria as 31,247Km<sup>2</sup> (3.2%) and 2,571Km<sup>2</sup> (0.3%) respectively.

Overgrazing and expansion of farmland were among the important causal factors reported by 21.9% of the farmers. Majority of the people in the area are either pastoralists or sedentary subsistence farmers whose agricultural activities in form of grazing, cultivation, bush-burning and irrigational practices contributed interactively to pasture degradation. Advancement in modern veterinary sciences and provision of water points have enabled bovine and other animal populations to increase in the Sudano-Sahelian zone of Nigeria. For instance, Gwandu (1991) puts the livestock population of Kebbi and Sokoto States at 14

million grazing on land mass of about 103,500Km<sup>2</sup>, an indication of a tremendous animal population pressure on available pastures in the area. Expansion of cultivated areas, especially in years of good rainfall is another important human factor in pasture degradation. The extension of agricultural activities to meet the food demands of ever increasing human population as being experienced currently to the erstwhile marginally productive semi-arid zone of the extreme northern Nigeria may be having negative impact on the highly sensitive ecosystems. Destructive agricultural techniques for cash crop farming like bush burning and use of heavy farm equipment may lead to an irreversible downward trend in carrying capacity of the land and turn the Sudano-Sahelian zone into the 'dust bowl' of Nigeria.

Recurrent drought was also been pointed out by 20.9% of the farmers as another cause of current pasture degradation in the study area. The degree of the impact of a particular drought on the environment and the extent to which it may be a disaster depends on a number of factors, such as the length of the period separating the drought from a previous one, the severity of rainfall deficit relative to a given mode of land use, the level of population pressure, and agricultural and water management practices (Oladipo, 2013). In general, drought in Sudano-Sahelian zone of Nigeria causes withering of pasture by 16% and crops by 42, parched fields, prevalence of sand dunes failing water supplies and southward movement of desert-like conditions by 9% (Oladipo, 2013), implying that desertification is still ongoing process. In more extreme cases particularly during the 1973 and 1983 Sahelian drought, it means hunger, famine, starvation and death of animals. in addition to dictating the onset of political change as experienced in Ethiopia in September in 1974 (Upah, 1987). However, except in extreme times of severe persistence, drought usually cures itself by giving way to an abundant rainfall for two or more seasons as experienced recently in Sudano-Sahelian zone of Nigeria (Abaje, 2013).

**Table 6: Distribution of respondents by causal agents of degradation**

Causal Agent	Frequency	Percent*
Deforestation	310	100
Overgrazing	268	86.5
Expansion of farm land	242	78
Drought	65	20.9

\* = n > 310 due to multiple responses (i.e. responses falling in more than one categories)

#### **Importance of Agrosilviculture for Environmental Conservation and Peace Management**

Agrosilviculture is a potential land use system to support food, fodder, fuel wood and other wood production and to increase the profitability of farmers. The main goal of Agrosilviculture is to optimise production per unit area while ensuring a sustained yield over time. Growing of trees on farms can help increase income, produce more fodder and food and protect the environment.

Table 7 indicated that 37.2% of the respondents stated that trees on their farmlands control soil erosion; while 19.5% reported that agro-forestry trees provided them with wood for other uses. A wide variety of products, for instance fodder, fruits, vegetables, medicine, cash crops and building construction are sustainably harvested from one land unit. By diversifying production this way, farmers minimize the risk of reduced income should one fail or the market price drops. Adedire

(2005) observed that the aggregate yield of diversified production exceeds the yield of single crop. The phenomenon arises because tree crops contribute significantly to soil improvement by supplying green manure to the soil. Some 21.9% farmers reported that trees control wind erosion in addition to reducing the rate of water run-off thereby encouraging high rate of infiltration, 11% indicated that agro-forestry trees conserve ground water

Trees increase soil organic matter and soil water-holding capacity, thereby lowering soil surface temperature and reducing evaporation of soil moisture through a combination of mulching and shading. Trees benefit livestock not only by reducing heat stress but also gains for animals which include eating and grazing for a longer period, needing less water, improving conversion efficiency of fodder, improved reproduction rates, better growth rates and high milk yields (Adedire, 2005).

**Table 7: Distribution of respondents by importance of agrosilviculture for environmental conservation and peace management**

Potentials	Frequency	Percentage
Soil erosion Control	116	37.3
Wind break	68	21.9
Provision of wood (Poles)	60	19.5
Ground water conservation	34	11
Reduction of conflicts	32	10.4
<b>Total</b>	<b>310</b>	<b>100</b>

#### **Suggested Measures for environmental Stability in the Area**

In Sudano-Sahelian zone of northern Nigeria, pastoralists have responded in a variety of ways to pasture degradation in order to reduce its ravage. Some adaptive strategies evolved over time and are usually integrated into the socio-cultural framework of the herders.

Table 8 indicated some of the responses adopted by the herders. In general, 40.5% of the respondents exploited temporary migration in the form of nomadic herding as strategic measures against pasture degradation during the dry season. During the same period there is also soutward

migration into the wetter microenvironment, combining upland and lowland ecotones to exploit the vegetative growth and water points of the inland valleys of the Guinea Savannah zone. In some cases, migration into the neighbouring countries is normally undertaken. Some 29.1% farmers reported that they supplement the feed of their livestock, especially during the dry season, with crop residues and concentrates. Some forms of agrosilviculture involving planted and scattered trees on farmlands were practiced by 30.4% of the respondents as a measure against pasture degradation.

**Table 8: Distribution of Respondents by Measures Adopted against Environmental Degradation and Conflicts in the Area**

Measure	Frequency	Percent
Enforcement of deforestation law	81	26.1
Prayer to God	45	14.5
Tree Planting on farmlands	94	30.4
Supplementary feeds	90	29
<b>Total</b>	<b>310</b>	<b>100</b>

### CONCLUSION AND RECOMMENDATION

There is a serious inadequacy of pastoral land in the zone. This situation naturally results into conflicts and sometimes ends in losses of life and properties. All respondents indicated that agroforestry has the capacity to rehabilitate the zone if properly practiced.

The following recommendations are stated, based on the findings of the study

1. There is a need to embark on deliberate pasture pasture in the Sudano-Sahelian zone of Nigeria to revert vegetation back to its position in order to enhance a sustainable livestock- pasture balance based on agroforestry practices.
2. There is the need to enforce grazing act of 1964 which appropriated 10.0 million hectares of forest reserve (and 98% of this was in Sudano-Sahelian zone of Nigeria), designated as grazing reserves for pasture.
3. Downward trend observed in forest land use indicates non-commitment of government at all levels to forestry development, hence the call for sensitization of the policy makers to accord true required priority to national forestry development in the Sudano-Sahelian zone of Nigeria.
4. Establishment of fodder bank by pastoralists is certainly timely and appropriate in the Sudano-Sahelian zone, especially as the land is progressively being taken over by other land uses. Agroforestry technologies introduction to the pastoralists should be gradual and with caution as faulty land selection, agronomic and husbandry practices may result in adverse consequences of non-adoption of the technologies.

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