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RESEARCH ARTICLE

THE ROLE OF POLICY INSTRUMENTS TO REALIZE SUSTAINABLE AND PRO-POOR DEVELOPMENT IN CÔTE D'IVOIRE, CASE OF SELECTION OF ENVIRONMENTALLY RESISTANT CASSAVA

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Abstract

During the current research, the present situation of cassava production and technology, as well as commercialization and consumption, were investigated in Côte d'Ivoire. The study included 800 value chain participants who were chosen at random from three ecological regions: south, west, and center. 300 farmers, 250 government regional district or village-based policy advisors, and 250 consumers were interviewed using a baseline survey form. According to the findings, approximately 35% of cassava producers are aware of the new cassava varieties, and more than 80% of those who are informed decided to utilize them. Traditional kinds are favoured by farmers (40 percent to 90 percent) over improved types, according to a study conducted in ecoregions. Despite the good yields, high food processing capacity, and taste features indicated by farmers, improved varieties Bocou 1, TMS4 (2)1425, and Bocou 2 are less popular for cultivation. More than half of the farmers said they would use the Rapid Seed Multiplication (RSM) approach. In contrast to the West and South, where pounded cassava is more commonly consumed, other locations examined prefer dehydrated cassava (Attieke) meal. Despite enhanced varieties' high yields and cassava growers' eagerness to adopt new cassava technologies, research and extension services should be strengthened to account for the ecological particularities of production, commercialization, and consumption.

Introduction:-

Cassava is a plant that grows year after year. Every part of the plant can be used in some way, although the starchy roots are by far the most popular. Except for the cassava seed, cyanogenic glucosides (CG) are found in every tissue. Linamarin is the most abundant CG (approximately 85 percent), followed by lotaustralin. The starchy roots are a good source of energy and can be boiled or processed for human consumption in a variety of ways. Roots can also be used to make native or fermented starches, as well as for animal feed in the form of dried chips, meal, or pellets. Sweet cultivars have less than 50 mg of CG per kilogram of fresh weight in the roots. Cassava roots are termed 'bitter' over this point. Bitter or sweet clones may be favored depending on the processing methods. Dry matter content, proportion of amylose in starch composition, protein, and carotenoid concentration are all important features for roots, in addition to their cyanogenic potential. There is a wide range of starch quality in terms of amylose percentage, with a mean of around 15%. Cassava roots are low in protein content with an average of about

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2–3 percent (dry weight basis). However, preliminary findings suggest that protein concentration in the roots of some landraces, particularly those from Central America, can be significantly greater (6–8%).

Cassava is a staple as well as a famine reserve crop, and it can be a valuable source of food when drought and conflict prohibit the production of other crops. The crop provides a significant source of calories for an estimated 40% of Africans [1]. Between 1968 and 2018, total world cassava production climbed from 93.08 million tonnes to 277.81 million tonnes, a 198 percent increase in production. According to a more optimistic forecast of demand and production growth, world production in 2025 will exceed 300 million tonnes. Despite the fact that Asian and South American cassava production is declining, Africa's production is continuously increasing, with an average annual growth of 2-3 percent, according to information provided by the International Food Policy Research Institute (IFPRI). Cassava (Manihot esculenta Crantz) is regarded a subsistence crop in many African countries, including Côte d'Ivoire because it thrives and produces well in low-fertility soils, locations with water shortages, and areas with little agricultural inputs. After rice and maize, it is the third most important source of calories in the tropics. Cassava consumption in Africa accounts for 62 percent of global production. The Sub-Saharan region is one of Africa's most productive regions. For example, in 2012, West Africa produced 80.9 million metric tons of cassava, accounting for 54.15 percent of total African production. The geographical location of Nigeria, the world's largest producer, justifies the statistics presented.

Côte d'Ivoire was the world's 13th largest producer in 2018, with 4.55 million tonnes. Cassava is the second most important food crop in Côte d'Ivoire, after yam. It's growing all throughout the country and the southern zone has a high output rate [2]. Innovative varieties generated through research, as well as new techniques of manufacturing and propagating plant material, have been made available to cassava sector actors in order to boost cassava production and access to planting material. Farmers have adopted three high-yielding cassava cultivars known as Bocou1, Bocou2, Bocou3 and TmS4(2)1425 that are disease and insect resistant. Traditional cassava varieties yield fewer than 20 tonnes per hectare per year, whereas these cultivars can produce 32 to 34 tonnes per hectare per year. In Côte d'Ivoire, aside from its historic usage in animal feed and more recently in ethanol production, cassava starch has a wide range of applications in the food industry, including paper and cellulose, textiles, biodegradable polymers, and pharmaceuticals.

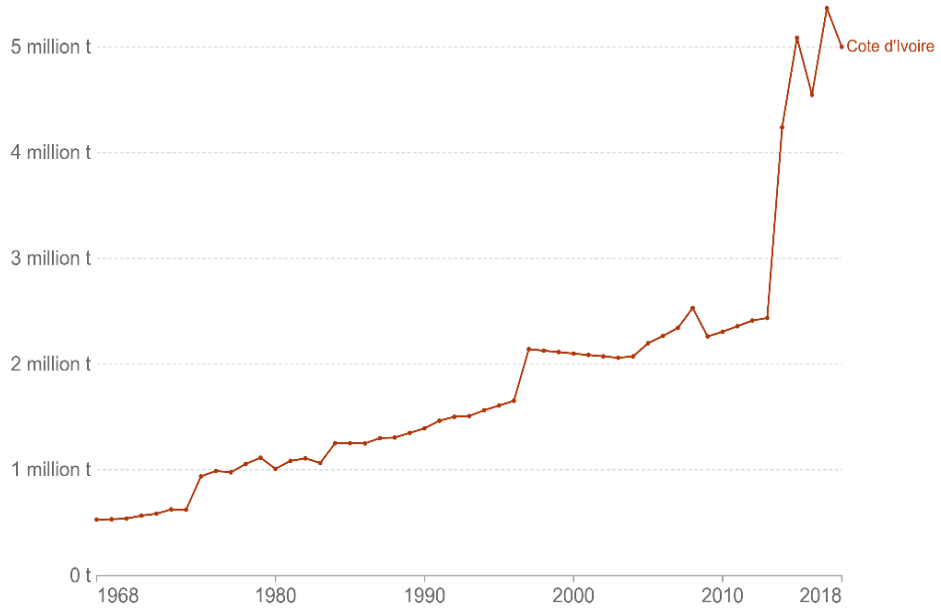

Figure 1:- Cassava Production between 1968 and 2018 in Côte d'Ivoire, measured in tonnes. Source: UN Food and Agriculture Organization (FAO).

The current study evaluates the actors in the cassava value chain's adoption of new innovations and technologies. It assesses policy instruments that can aid Côte d'Ivoire's long-term development through progressive cassava production, with the goal of selecting elite seeds fit for Côte d'Ivoire's distinct location and environment. The study

also assesses the existing status of production as well as the barriers to increased crop dispersion throughout the value chain.

Literature Review:-

One of the most difficult difficulties we face is producing enough food in a sustainable manner to meet the needs of an ever-increasing global population. According to recent predictions, food production will need to double by 2050 [6]. The decline in arable land due to environmental degradation and urban encroachment, increased costs and potential shortages of fertilizers, rising atmospheric carbon dioxide (CO2), and climate change, all exacerbate the ability to meet this aim. The debate over climate impacts and adaptation in the context of food security has mostly centered on yields. Food security, on the other hand, is defined as "all people having physical and economic access to sufficient safe and nutritious food to suit their dietary needs and food preferences for a healthy and active life at all times [7]. Cassava leaves contain a significant amount of protein. They have the potential to decrease malnutrition and provide food security in poor tropical and subtropical areas. Due to their massive vegetative development, interspecific cassava hybrids with some wild species such as M. neusana and M. anomala can play a vital role in delivering a bigger amount of protein. Cassava cultivars used for cooking are excellent prospects for having their leaves improve grain crop flour. Because of these factors, employing cassava leaves as a protein source is a highly sustainable technique [3].

Following the introduction of new varieties, certain research on cassava productivity in Africa were done [4]. In Sub-Saharan African nations such as Ghana, Nigeria, Zambia, Tanzania, Uganda, and Sierra Leone, for example, empirical evidence shows that adoption rates of improved cassava varieties are modest, but some advances have been documented [10,11,12,13]. Nigeria's adoption rates appear to be greater than those of the other countries indicated. According to other studies, cassava productivity and efficiency are improving in Africa, but access to necessary inputs such as loans, extension services, and improved cassava varieties is still a problem [5].

Several regulations have been set to improve the situation among several African countries. For instance, according to a recent exploratory study presented [8], the Federal Government of Nigeria created policy measures that boosted cassava industry, such as 10% cassava bread, 10% bioethanol in gasoline, and the replacement of paraffin with ethanol gel fuel as a cooking fuel. According to the report, policy improved investment and employment in the cassava subsector, lowered Nigeria's food import bills, and raised cassava production from 10.8 to 20 tonnes per hectare. Nigeria became the world's greatest cassava grower as a result of these policy successes. Despite the fact that the initiative had some excellent outcomes, some academics [9] claimed that there was insufficient central coordination between the organizations engaged in its implementation. According to the regional secretariat of the policy facilitators, there was a paucity of data (especially on processing and marketing) after the program was implemented, making it difficult to assess the program's impact on the aims.

Cassava production in Sub-Saharan Africa, particularly in Côte d'Ivoire, must be boosted to meet the expected growth in demand for cassava food and non-food products, as well as to realize the crop's immense potential [14,15]. Pests and diseases produced by bacteria and viruses, which result in significant output losses, are among the production restrictions [16,20]. Another drawback is the cyanogenic glucosides, which upon hydrolysis, produces toxic hydrogen cyanide. Cassava is an energy-dense food, mainly composed of starch with low levels of protein and other nutrients important for a balanced diet. Populations that consume cassava as a staple are at high risk of protein, vitamin A, zinc, and/or iron deficiency [17]. We may presume, based on the previous investigation, that there are various problems that influence the cassava breeding aims in Côte d'Ivoire:(a) high dry matter yield per unit land area; (b) disease and pest resistance, including cassava mosaic disease (CMD), cassava brown streak disease (CBSD), and cassava bacteria blight (CBB), as well as pests including cassava green mites (CGM) and whiteflies; (c) enhanced starch quantity and quality; (d) reduced hydrogen cyanide prospects; (e) improved nutrient value or biofortification; (f) adaptability to a range of climates; (g) improved plant type for automation; and (h) end user characteristics, such as processing, cooking, and organoleptic properties [18, 19].

By using macro-level research to quantify the impact of federal policies on cassava output, regional food supply, and nutrition security in Côte d'Ivoire, this study makes a significant contribution to closing the knowledge gap. The study's key research question was: What policies could be implemented in Côte d'Ivoire to assure long-term growth and steady food production and security? After conducting a thorough review of the literature, it is discovered that just a few studies have been conducted on the potential policy instruments for increasing cassava output in Sub-Saharan African nations, with little or no documented related research in Côte d'Ivoire.

Methodology:-

Divisions by Region:-

Three agricultural zones may be found in the country: West (Man), Center (Bouaké), and South (Bouaké) (Dabou, Bingerville and Bonoua). The topography in the West is mountainous, with average rainfall ranging from 1500 to 2200 mm and two seasonal changes: dry and rainy. The climate in the Centre is an attenuated tropical transitional climate, with amount of precipitation ranging from 1500 to 2200 mm and four distinct seasons: two dry and two rainy. The climate in the South is equatorial transitional, with annual precipitation spanning from 1300 to 2400 mm and four specific seasons: two relatively dry and two wet. Climatic condition, the significance of cassava production, processing, monetization, and consumption, as well as the amount of technology in diffusion, were the division's criteria.

Innovations: -

The National Centre for Agronomic Research (CNRA) in Côte d'Ivoire developed and implemented two types of technology in cassava fields. Enhanced variants (Bocou1, Bocou2, Bocou3, and TMS4), as well as a technology termed as Rapid Seed Multiplication by Rationing (RSM) which were under study during the research.

Information Gathered and Analysed: -

A total of 800 participants were polled using questionnaires, including 300 farmers, 250 government regional district or village-based policy advisors, and 250 consumers. Farm management and cultivation practices (cultivated and/or preferred varieties, frequency of cultivation), marketing and processing activity (derived products, markets, and prices), and the use of new technologies were among the variables investigated (processed products and frequency of consumption). Descriptive statistics were used extensively in this study. Data was analysed using the Statistical Product and Service Solutions (SPSS) statistical program. SPSS was chosen because it works well with both quantitative and qualitative data. The time it takes to analyse data using SPSS is significantly less than with any other statistical program.

Results:-

Characteristics of Farms, Adoption of New Technologies, and Output: -

The survey outcome collected from local farmers shed some light on the situation of cultivated and preferred varieties by farmers in Côte d'Ivoire which is shown in Table 1. Traditional varieties Yace (35.4 %), Agbable (16.2 %), and Essakpel (14.8 %) were the three most cultivated varieties, with farmers preferring them owing to excessive consumer demand (27 %), high quality for food manufacturing (18 %), and the early development of maturity (9 %).

Despite good yields, improved food manufacturing, and better taste qualities reported by farmers, improved cultivars were less favoured for cultivation (Bocou 1 (13.3 %), TMS4 (10.67 %), and Bocou 2 (8.23 %) in the study. However, results prove higher acceptance of new variants among farmers when compared with similar survey dated back to 2018 by Adolphe et. al. which revealed the preference results of (Bocou 1 (10.67%), TMS4 (0.67%) and Bocou 2 (0.67%)). Yet, it's also worth mentioning that the survey of 2018 only got response from 150 farmers and they were not disseminated proportionately among regional divisions [21]. The low use of improved varieties in cassava farming was found to be attributed to the competitiveness of traditional varieties and disparities in adaptability between agricultural zones, according to the study. The second reason could be that superior varieties have only been available since 2010, which is just over a decade.

Table 1:- Cultivated and favoured cassava varieties by farmers in Côte d'Ivoire.

Rank	Variety Name	Variety Type	Cultivation (%)	Preference (%)	Reasons of preference
1	Yace	Traditional	35.4	27	High market demand
2	Agbable	Traditional	16.2	18	Food processing
3	Essakpel	Traditional	14.8	9	Precocity cycle
4	Bocou 1	Improved	13.3	13.3	High yield
5	Akrabatchin	Traditional	3.33	6.45	Food processing
6	Assuable Tambou	Traditional	3.33	2.67	Taste
7	TMS	Improved	2.67	10.67	Food processing
8	Bocou 2	Improved	2.67	8.23	High yield, Taste
9	Dabou	Traditional	2.67	2.67	Precocity cycle

10	Zogloble	Traditional	2.67	0.67	Food processing
11	Sans manquer	Traditional	2	0.67	
12	Vitesse Traditional	Traditional	0.96	0.67	High market demand
	Total		100	100	

As shown on table 2, the first preferred variety (Yace) is most cultivated in the west (80.0 percent) regions, while the second favorite variety (Agbable) is most cultivated in the country's center (66.7 percent). Within ecological zones, it was discovered that Bocou 1 had a larger percentage of improved varieties cultivated, with 33.33 percent in the south and 28.67 percent in the west. Farmers in all regions studied have not yet begun to plant the cultivar Bocou 3.

The study also discovered that knowledge levels differed by ecological location.The percentages of knowledge in treated regions where techniques were introduced ranged from 32% in the West to 60% in the Centre and 95% in the South.While in zones where technologies have still not been implemented, the level ranged from 10% to 30%.It was also shown that more than half of cassava growers who were exposed to new technology opted to utilize new kinds.The findings point to a significant knowledge gap where the government should do more to educate most farmers about the new types of cassava breeds.

Table 2:- Cassava types grown in Côte d'Ivoire's ecological regions.

Region	Variety Name	Variety Type	Cultivation (%)
Center	Bocou 1	New	6.67
	Agbable	Old	66.67
	Bonoua	Old	6.67
	Okou	Old	3.33
	Yace	Old	3.33
	Zogloble	Old	13.33
West	Bocou 1	New	28.67
	TMS	New	3.33
	Dabou	Old	13.33
	Tetoh	Old	3.33
	Yace	Old	80
South	Bocou 1	New	33.33
	Bocou 2	New	-
	Essakpel	Old	23.33
	Manioc doux	Old	3.33
	Sans manq	Old	10
	Yace	Old	30
	Akrabatchin	Old	16.67

Producers were eager to embrace new types, but the given acreage were still inadequate. The overall average area was 0.74 hectares, with several types ranging from Bocou 2 to TMS4.The average plantation density was 769 plants per hectare, accounting for 7.69 percent of the total area.

Improved varieties were found to be less commonly used for cultivation in a previous study. Farmers in the southern and eastern sections of the country had adopted the cultivars Bocou 1, Bocou 2, and Bocou 3 according to research published in 2014 [22]. The results of that survey revealed that these types were favourably received by the general public. However, It would take longer for them to be adopted. Farmers continued to plant and prefer non-improved cassava varieties during the previous decade. Despite the growers' strong desire to employ new kinds, acceptance was remained low in practice in several ecological regions of Côte d'Ivoire.The low yield dry matter (LYDM) of novel kinds Bocou 1, Bocou 2, and Bocou 3 and lack of knowledge of TMS4 (2)1425 were the causes for reduced use of new technologies.It is necessary to raise awareness of improved seed varieties and technology for quick seed multiplication.It has been well demonstrated that new technology methods are accepted over time.After individuals have gone through certain mental processes to accept the technology, the adoption will be defined as the continuous usage of innovation.Personal attributes, traditional beliefs, institutional, and socio-economic considerations all had a role in the acceptance of enhanced technology.Different processes such as awareness, curiosity, appraisal, and trial

could also be used to describe it. As most researchers believe, the rate of acceptance of enhanced technologies is higher when they are simple to use.

The current state of production was calculated based on the data obtained, and the results were given.Cassava yields were estimated to be 17.26 tons per hectare per year.In terms of cassava production, the study found that the existing condition of cassava production was low, based on the average yield (15 and 33 tons/ha) that could be produced for improved varieties in rural regions estimations submitted by CNRA, 2014.Often, the rootstocks had a low yield potential.In Côte d'Ivoire, cassava technology adoption was actually quite low.As a result, growers should focus on high-yielding landraces as well as new improved varieties and landraces.

Cassava Commercial Production and Consumption Analysis: -

Different eras of commercialization were discovered by comparing localities of ecological zones.The main market supply periods were January to March for central locations and July to September for western locations, while it was perpetual for southern locations.Transformers (60.32 percent), wholesalers (17.46 percent), and retailers (9.52 percent)were among the relevant stakeholders in the cassava value chain.Transformers account for a significant section of the value chain.Wholesale (40.80 percent) and retail markets (12 percent), as well as households(47.20 percent) are the final destinations for cassava products. Wholesale markets in the west (62 percent) and south (97.67 percent) were the most popular destinations, while households in the centre were the most popular (89.47 percent).

Table 3:- Characteristics of Cassava Commercialization.

Region	South	Center	West
Harvests and Markets supply periods1	Permanent	January to March	July to September
Actors (by average mean)			
Transformers	60.32%		
Wholesalers	17.46%		
Retailers	9.52%		
Destinations (by average mean)			
Wholesale markets	40.80%		
Retail markets	12%		
Households	47.20%		

Traditional cassava varieties were the most popular in Côte d'Ivoire, according to the primary features of cassava consumption.VarietyDabou (17.36 %) was largely used for mashed cassava, while Yace was treated as fermented paste (42.54 %) or dried cassava (51.13%) for local delicacies Placali and Attiéké.There were discrepancies in the analyses conducted within ecological zones.Other traditional varieties were employed in the Centre (Agbable38.74 percent) and in the South (Akrabatchin 60 percent), in contrast to the West, where variety Dabou was used for pounded cassava.

Traditional cassava varieties are still widely consumed in Côte d'Ivoire per this study.Dried cassava or Attiéké was widely consumed, and the traditional cultivar Yace appears to be well adapted and most widely utilized by transformers in the diverse natural regions studied.It is generally known that Attiéké is Côte d'Ivoire's largest cassava processing commodity.Improved cultivars' adaptability to food processing in dry products like Attiéké should be emphasized.The obstacles and challenges that prevent cassava processing actors from realizing the intended yield in terms of output, consequently affecting their profit, were not addressed in this study.Indeed, the processes used to make Attiéké were much the same as those used to be in the past. Except for grinding, the production process was extensive and occasionally tedious, with most activities still being done manually.In the particular instance of the adoption and implementation of improved cassava processing technologies by women entrepreneurs in the south-west of Nigeria, several scholars [23] found that the high equipment cost, non-availability of equipment, difficulty of operating the machinery and equipment, and insufficient knowledge were the major challenges preventing the adoption of the improved cassava production technology.

Conclusion and Suggestions:-

Cassava varieties that are environmentally robust and newly produced were compared to classic cassava varieties in Côte d'Ivoire. Although selected enhanced variations show excellence in almost all aspects of cassava utilization, the data gathered revealed that traditional varieties continue to produce, commercialize, and consume more than

enhanced kinds introduced in ecological regions. Research and training services should be strengthened, taking into account awareness and cultural ecological particularities, based on excellent yields of improved varieties and cassava growers' strong desire to adopt new cassava technologies. These issues must be solved in order to enhance adoption and profit margins.

The cassava sector in Côte d'Ivoire should be envisioned as a dynamic industry that contributes considerably to economic development, national peace and stability, and the enhancement of the Ivorian people's living standards. The government and ruling parties should form a mission to establish a sustainable cassava sector as a major agricultural and economic engine in attaining economic agenda and poverty reduction objectives.

Suggested Strategy for The Development of Cassava Sector: -

Following many meetings, expert advice, and relevant contributions from various levels of the cassava value chain, a strategy is developed that focuses on the following six goals:

Goal 1: Building powerful institutions. Public-private partnership (PPP) mechanisms should be coordinated for sector strategy, framework development, policy formation, and alignment.

Goal 2: Conducting a thorough sector study in order to make informed decisions on current empowerment opportunities and incentives.

Goal 3: Providing appropriate sustainable production and processing along the value chain, developing and strengthening access to inputs and R&D.

Goal 4: Encouraging small-scale farmer organizations and stimulating them to think like entrepreneurs.

Goal 5: Enhancing access to capital throughout the value chain.

Goal 6: Attaining quality, consistency, and quantity, improving access to technology for processing.

Important Tasks to Be Completed: -

The following major activities should be implemented in order to attain the defined objectives:

Activism and Institutional Development: advocating for the adoption or revision of strategic policies and legislation, as well as budget allocation, should be part of these activities. The National Cassava Sector Coordinating Committee should be established, and other important institutions such as producers and processing associations should be strengthened.

Gathering and Disseminating Market Information:

This component should include conducting market surveys and disseminating important information to all stakeholders.

Research and Development:

This area should cover the creation of participatory programs and projects to help meet the strategy's manufacturing and distribution needs.

Provision of Training:

As required by the strategy, bridging knowledge gaps through training, coaching, and mentorship to ensure that producers and manufacturers perform well in fulfilling market demands.

Improving Output, Manufacturing, and Commercialization: This will require technical assistance to farmers, processors, and distributors.

Mobilization of Resources:

The Strategy will require significant financial, human, and material resources to be implemented successfully. As a result, government backing, co-funding international institutions, and involvement from other stakeholders should be organized.

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